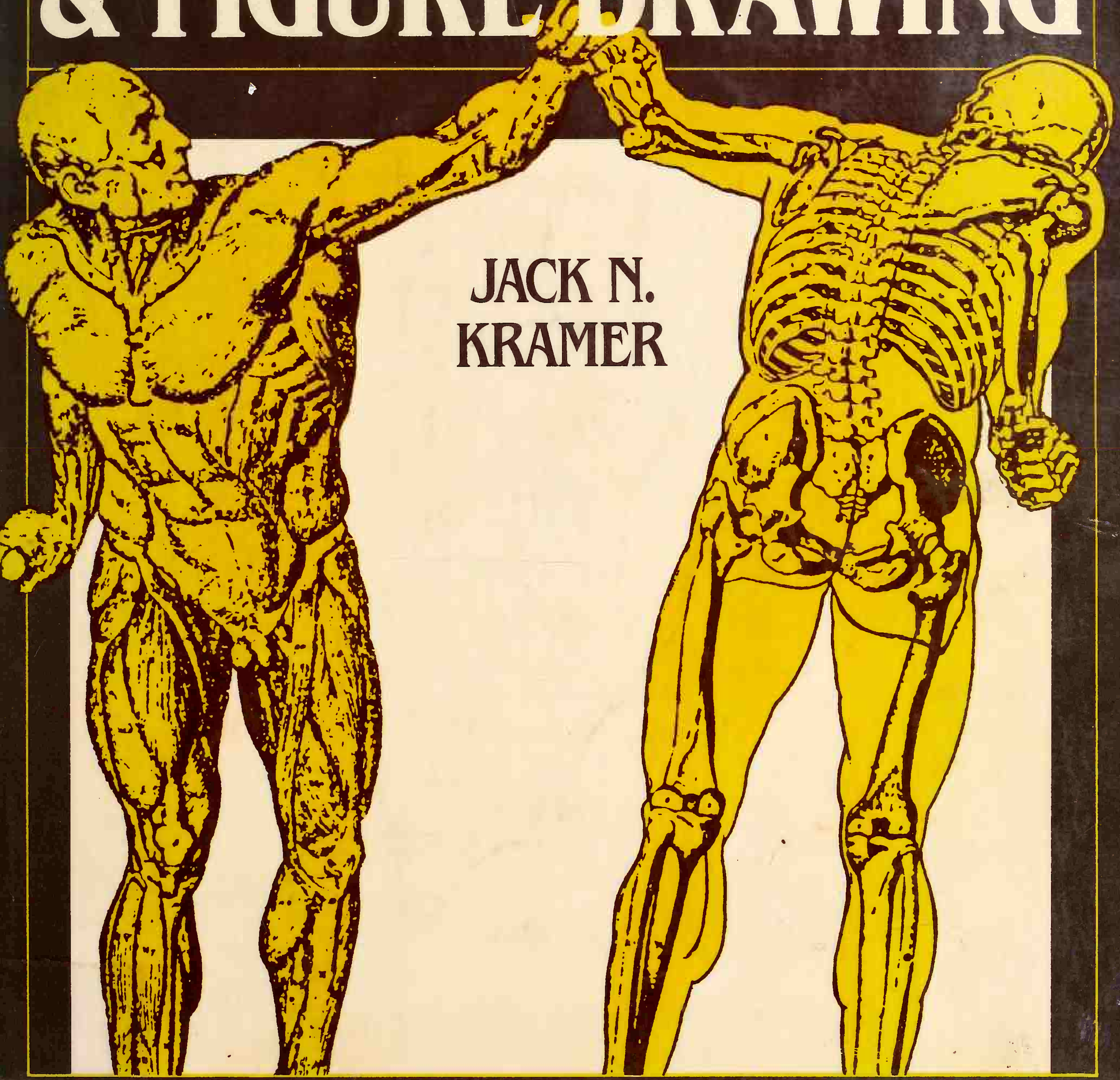
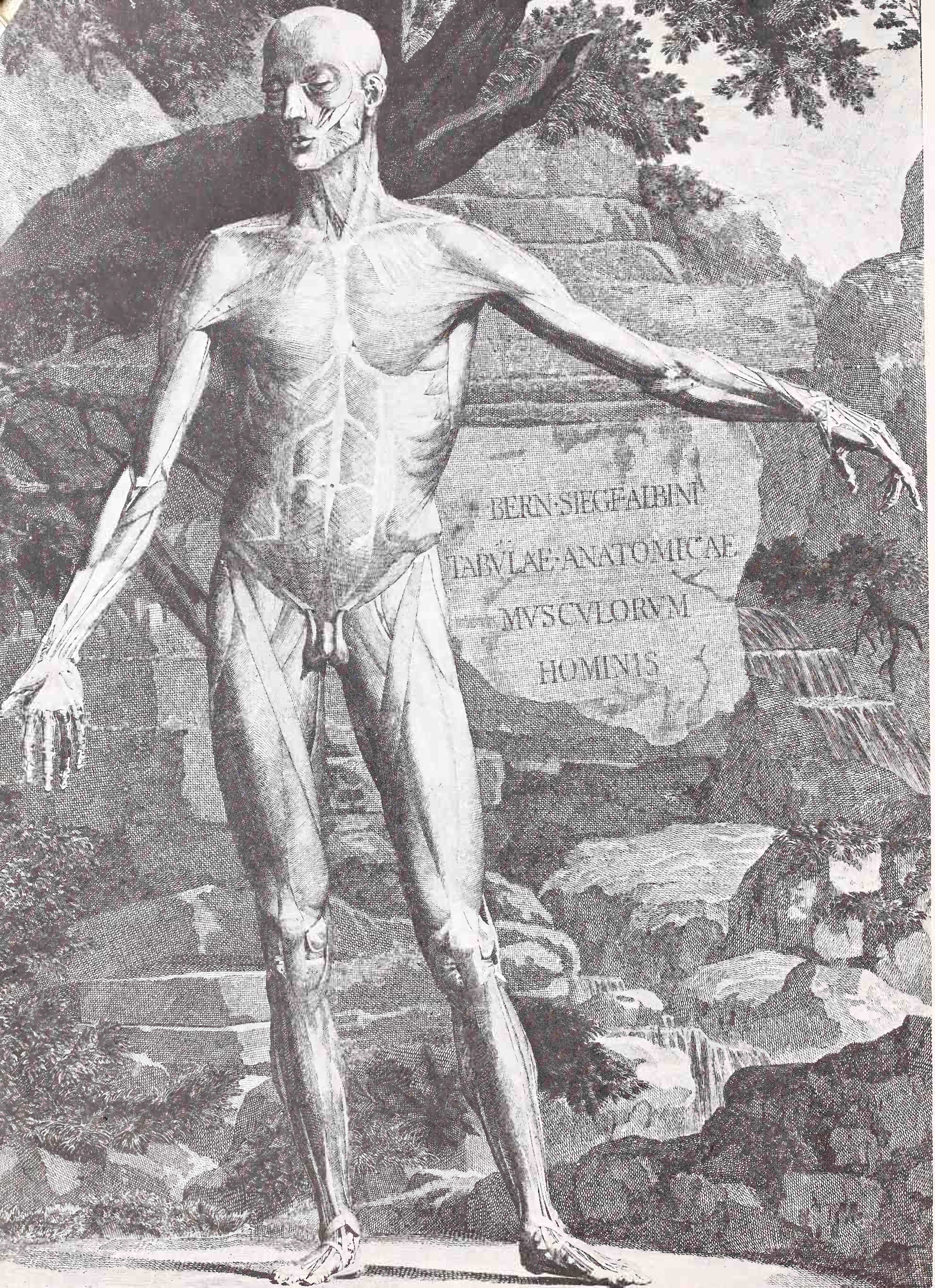
HUMAN ANATOMY & FIGURE DRAWING



JACK N. KRAMER

THE INTEGRATION OF STRUCTURE AND PERSPECTIVE

SECOND EDITION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Second Edition

HUMAN ANATOMY AND FIGURE DRAWING

THE INTEGRATION OF STRUCTURE AND PERSPECTIVE

JACK N. KRAMER

VNR VAN NOSTRAND REINHOLD COMPANY
New York

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To my mother, Sarah Kramer

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PREFACE

This revised edition of *Human Anatomy and Figure Drawing* has been generously expanded in text and image. I am privileged to share with the reader the elaborately labeled engravings from Jean Leo Testut's *Traité D'Anatomie Humaine.* These engravings were labeled in English by Frederick Henry Gerrish, professor of anatomy at the Medical School of Maine, Bowdoin College, for his *Textbook of Anatomy*. An American nineteenth-century anatomist, Gerrish was convinced that drawing as a skill "can be cultivated to such an extent as to be wonderfully serviceable to the medical student." He did not anticipate that his own line drawings of the origin and insertion of muscles (which accompany the Testut engravings) would later serve the art student. Many additional anatomically relevant masterworks have been secured for the present edition.

A completely new section on the influence of anatomy on the costumed figure provides a more direct application of anatomy to figure composition and illustration.

For the instructor in figure drawing and the teacher of anatomy, an innovative new chapter on planning an anatomy course will suggest a number of ways to implement instruction. A new appendix provides sources of supply for skeletons, charts, muscle casts, slides, and films. The expanded compendium offers a quick, condensed anatomy reference, with diagrams indicating the surface location of bone, fat, and superficial veins.

The preparation of the revised edition has benefited from the valued assistance of a number of individuals to whom I wish to express my thanks: to Iso Papo for special new photographs; to June Mendelson for editorial corrections; to Samuel Goldring for thoughtful suggestions; to Stephen Ford for typing; and to colleagues and former students for graciously permitting their works to be included. Their names accompany the captions.

The following titles have been shortened in the captions with the permission of the Rare Books Department of the Boston Medical Library in the Francis A. Countway Library of Medicine: Bernhard Siegfried Albinus, *Tables of the Skeleton and Muscles of the Human Body;* Antonio Cattani, *From twenty plates representing the Osteology and Myology of the Human Hand, Feet, and Head;* Jules Cloquet, *Anatomie de L'homme ou descriptions et figures lithographiees des toutes parties du corps humain;* Jean Cousin, *L'Art du Dessin;* Julian Fau, *Anatomie of the External Forms of Man Intended for the Use of Artists, Painters, and Sculptors;* Jean Galbert Salvage, *Anatomie du Gladiator Combattant Applicable aux Beaux Arts ou Traite des Os, des Muscles, du Mechanisme des movements, des Proportions et des Caracteres du Corps;* Hercules Lelli, *Engraving on copper of the Muscles of the Human Body.*

INTRODUCTION

Two developments have advanced visual knowledge in figure drawing. The first was the invention of geometric perspective. The second was the study of human anatomy. The artist has made use of both in understanding the human form. The integration of surface anatomy and geometric perspective represents an exacting synthesis of visual insight in drawing.

Despite the availability of information on anatomy, little beyond general alignment has been written on its systematic integration with perspective structure. The investigation and development of the specific relationship between anatomy and perspective is open to extensive examination. The study of artistic anatomy will sharpen observation and identify the cause of complex surface form.

But the perspective of the human body (foreshortening) has not been adequately explained in relation to skeletal architecture and muscular volume. Familiarity with surface anatomy is, therefore, only part of the excitement of drawing the figure. The challenge for the artist is to provide a visual context that is internally consistent, a spatial order in which the parts of the figure coordinate with one another and with the surrounding space. Drawing from the living model is the means to complete one's understanding of the human form in perspective. With progressive visual examination and drawing practice, the artist will accumulate a vocabulary of remembered forms to serve his creative interests.

The study and analysis of spatial order in the human form should not interfere with expressive intent or the integrity of personal style. Indeed the appearance of a coherent three-dimensional spatial system coincides historically with the period remarkable for the development of individuality—the Renaissance. Structure developed as a tool to serve visual investigation and the extension of visual knowledge. It was an aid to expressive vision. "The theory of art developed in the Renaissance was intended to aid the artist in coming to terms with reality on an observational basis; medieval treatises on art, conversely, were largely limited to codes of rules which could save the artist the trouble of direct observation of reality. . . ."[1] When mastered, structure can be integrated into the fabric of expression or stylized form.

Structure, discovered in visual reality and objectified in drawing, can become part of a formal, remembered visual language stylistically reshaped by content and meaning. It supplies an orderly underpinning of measured space to give support and conviction to artistic purpose. The lengthened ethereal forms of El Greco, the robust earthy forms of Rubens, the afflicted, obsessed figures of Schiele, and the formal poetry of Villon reflect an originality of stylistic expression, sustained and integrated by a consistent space structure.

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1. Erwin Panofsky, *Meaning in the Visual Arts* (New York: Doubleday and Company, Anchor Books, 1955), p. 278, footnote 114.

PART ONE: STRUCTURE AND FIGURE DRAWING

CHAPTER 1

VISION AND ABSTRACTION IN DRAWING

Vitality in the visual arts stems from that most precious organ of sense, the eye. Perception, for the artist, is more than a passive response to an environment. It involves intense active awareness, a focus on visual reality as the source of those forms that make up the language of visual expression.

It is a function of drawing to enlarge the artist's vision and his vocabulary of forms. The media for drawing are simple and facilitate the acquisition of drawing skills. Skill in drawing may be consciously acquired in structured learning exercises. The visual facts are made useful when the artist has acquired the proficiency in drawing to render his observation concrete.

When forms are complex, visual study may demand extended attention and effort. Probably the greatest challenge to visual comprehension, the one requiring exceptional concentration, is the human form. Part of this challenge stems from the intricate organic anatomy of the figure continually altered by movement. Without the study of anatomy, a simple straightforward retinal response to surface forms, no matter how accurate, tends to result in figures that convey static, nonresilient images. Like the inert forms of a still life, they remain fixed, with predictable relationships. But the form of the human figure is modified by the slightest gesture, into a new disposition of parts to the whole. For example, a turn of the wrist can alter the shape of the forearm. How this apparently simple change occurs is explained by the study of artistic anatomy. Among other considerations, a proper study of surface anatomy examines in an organic way the significant mechanics of movement. Since it probes beneath the skin, anatomy makes the eye more acutely sensitive to subtle tensions and organic connections. The eye of the artist will distinguish between hard bony surfaces and mobile muscular tissue.

A knowledge of skeletal architecture provides a clue to the dimension and axes of form units. A knowledge of the origin and insertion of major muscles explains their function and shape in relation to bone. But the study of artistic anatomy requires a visual context that will make it something more than a blueprint of the body. The knowledge of the anatomist and the clarity of the medical illustrator provide the essentials of anatomic information. The artist must extend its application to the broader realm of a form in three-dimensional space. The disposition, in drawing, of the anatomically articulate figure, within a cohesive spatial order, represents an impressive synthesis of two visual disciplines—surface anatomy and freehand perspective.

In drawing, the graphic approximation to human vision is geometric perspective. To some the connection between anatomy and perspective may not be immediately apparent. But it is the relationship between anatomy and the broader principles of perspective that must be examined and understood if the artist is to develop reliable spatial consistency in figure drawing.

The student may have some experience and theoretical understanding of formal perspective and form projection based on simple geometric solids (i.e., sphere, cube, cylinder, etc.) and their relationship to the human form (the cylindrical characteristics of an arm, for example). Forms are a fundamental part of the language of spatial relationships employed by the artist. Viewed as an introduction to the explanation and understanding of spatial concepts, simple geometric solids have a real and obvious utility. Unfortunately, these same geometric forms are frequently translated into simplified stereotypes of head and body, and such stereotypes are inadequate to describe the living form. A simplified physiognomy is too remote from the true aspects of anatomic structure. The too-insistent visual effort to impose the simple geometric solid on a complex human form may discourage and frustrate visual investigation and inhibit the growth of knowledge and understanding of the figure. The simple geometric solid (cylinder, as an arm), while it may seem to be a reduction to the essentials of a form, is, in fact, a complex and complete concept in itself. It has its own intact, finished character and therefore is of limited adaptability.

The human figure is an intricate interrelationship of organic units. To reflect precisely its significant spatial characteristics requires a very basic structural symbol—one that will mirror the figure selectively, but on a unit-for-unit relationship within a form. To fit varied situations such a symbol has to be simple, neutral, and adaptable. The space in the very complicated human form can best be explained by the most primary spatial abstractions—the bare essentials of space measurement (and its symbols, point and line).

THE REPRESENTATION OF THREE-DIMENSIONAL STRUCTURE

Perceptual judgment, to be useful in drawing, must move to a level of visual abstraction more fundamental and adaptable than the geometric form, to an abstracted base that is common to both complex and simple forms. All forms are composed of lengths in various relationships. Understanding a complex form like the arm, for example, does not ultimately consist in visualizing the arm as a simple cylinder, but in reducing both the arm and the cylinder concept to their common dimensional components.

Dimensions are measurements of lengths of space. In figure drawing they mark an inner coherence of measured distance in three directions taken from surfaces and forms. The dimensional attributes of height, width, and depth represent, within a form, its space-filling capacity—its spatial quantity. An understanding of this abstracted characteristic of forms is important. Quantity (from one dictionary) can be described as that which has magnitude, size, volume, area, or length. Recognizing quantities of length in three directions within volumes is fundamental to an appreciation of the space of a figure. It is a function of intellect, distinct from, but based on, a visual sense response.

Quantity (dimension) as such has no actual, separate, concrete existence. It cannot be isolated from its identity with material substance (and its attendant qualities: color, texture, etc.). "Quantity considered in itself, apart from the sensible qualities with which it is always found, is seen to be a constituent of all material bodies. There is no actual quantity which is not the quantity of something."[1] But it can be understood and abstracted as a concept. The idea of the space of a form can be intellectually divorced from all its visible attributes, that is, from material substance, surface texture, color, shape, and value (light and shade). Identifying the figure's space involves the abstraction, from a form, of the dimensions of height, width, and depth as distinct, isolable factors. Spatial quantity

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[1] Francis J. Collingwood, *Philosophy of Nature* (New York: Prentice-Hall, 1961), p. 72.

(i.e., dimension) can then be given a separate, "symbolic" existence as measurement (like a ruler, a yardstick, or an eight-ounce measuring cup). The measurements of a form, its dimensions, thus give autonomous identity to its space-occupying capacity. For example, a tailor's measurements for a custom-made suit provide spatial data separate from the figure—in effect, a symbolic, nonsensuous construct that equals the volume of the human form.

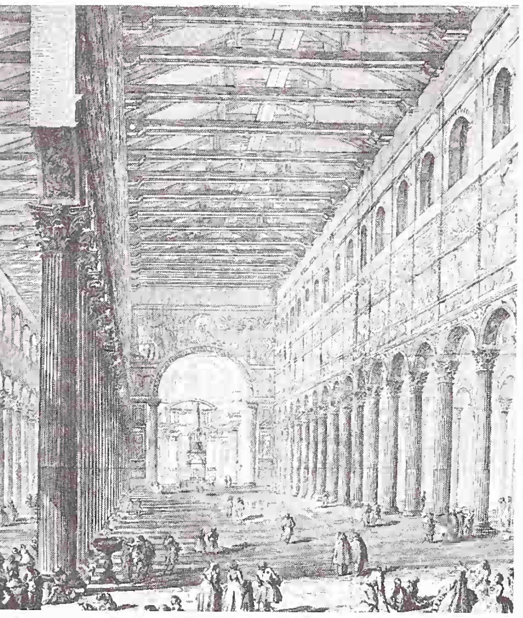
To isolate, in a form, the primary aspect of the purely spatial (the abstracted quantity of a form) from its sensuous apprehension by color and light, it may help to think of an object in a dark room. By physical contact its space-filling dimensions of height, width, and depth can be grasped as clearly distinct from optically perceived qualities (color, light, and texture). One can remove one's hands from an object and, by the distance between them, retain a measured space (an inch, a foot) independent of a given form (like the frustrated fisherman indicating the size of the one that got away). In a similar fashion, a length of line, in drawing, can function as a symbol for a "length of space." (Each hand in the foregoing demonstration independently indicates a spatial position; correspondingly, a point in drawing can specify a spatial location, a specific place, that is the origin of a length of space.)

The nature of space and the discovery, within forms, of its main attributes—location, direction, and dimension—provide the basis of a rationally consistent visual language in drawing. These spatial attributes can be observed and abstracted as a unified construct, free of sensible qualities (color, texture, light, and shade) and can thus be symbolically understood. Dimensions in drawing can be given a separate graphic identity by line and point; but dimensions in themselves remain conceptual attributes apparent to the eye, as sensed experience, only in the context of color, shape, and value. (Quantity has no separate identity.)

The primary function of line in drawing has been overshadowed by an undue emphasis on the "quality" of line in graphic description. Line quality—the capacity for implied textural description (i.e., hardness, softness, roughness, etc.) or value emphasis (light and dark line)—in both a general and specific sense is not the only purpose of line in drawing. Line has a very comprehensive function that has been largely obscured by an almost total and exclusive consideration of its "qualitative" possibilities.

The distinction between the immediate visual perception of "qualities" (i.e., color, texture, shape, substance) and the "secondarily" deduced factor of visual spatial "quantity" as an independent abstraction represented in drawing by location and length (graphically stated as point and line) is not apparent in the immediate act of drawing. The seeming directness with which one can describe a form with line can be deceptive of what a line represents. Line is not a representation of a sense impression in the direct sense that color is. (One can record on paper or canvas a directly seen color-value; but a line drawn on paper is not a reproduction of another line seen on a form.) Line, in observational drawing, is not a record of direct visual sensation.

What, then, does a line represent? It depicts something deduced from sensations. Since the defining characteristic of a line is length, a line represents an abstraction of length taken from directly sensed phenomena. The full meaning of that old truism, "There are no lines in nature," becomes evident when line is understood as a symbol for quantity (i.e., length measurement). Line is a means to give identity to space (length) separate from the direct visible sensation of qualities (color, value, texture, shape). (The point, as a symbol for position or location in space, will be discussed in detail later. As a symbol, it is less obvious, generally an implied but critically essential factor in drawing. The point establishes position; line defines length.)



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1-1

Detail from Interior of St. Paul Outside the Walls (engraving) by G.B. Piranesi. (Collection: the author. Photograph by Jonathan Goell.)

The columns and figures are seen in perspective. The forms visually are reduced in size in a receding space. The major converging perspective lines meet at the column supporting the left side of the arch.

Length and position are the basis of an intelligible space representation in drawing forms. All else is embellishment. The embellishments are important. They are the specifics of sense experience, qualities that amplify and give meaning to forms. But without a secure abstract underpinning of spatial order, forms may be dissipated into meaningless, unrelated superficialities—an incoherent pattern of light, shade, shape, and texture.

Line is often viewed as an edge, but line is not the simple equivalent of the margin of a form. To consider line merely as an edge is to leave unidentified its major significant function as measurement (as a container of quantity). Furthermore, to equate line with an edge is to substitute one abstraction for another. Edges cannot, in themselves, be detached from the surfaces of which they are a part. When they are mentally identified as ''detached edges,'' they have, indeed, become an abstraction.

In observational drawing, a ''seen'' three-dimensional quantity, as an abstraction, undergoes a perceptual modification. Perspective is a factor. Obviously, in observed forms, visual extent—length as it relates to the dimension of depth (i.e., distance)—is perspectively altered by vision. It is not an ''actual'' measured length. Columns (or telephone poles) each of the same length are perspectively diminished in size as they recede in space from the viewer [1-1]. Or, an arm projecting toward the observer might have a visually foreshortened length of ten inches when its actual measurement is thirty inches. What should be distinguished, however, is the attribute being abstracted, a length of space that equals the observed extent of a form.

Space, in observed forms, is an abstraction of visually measured dimensions removed from perceived reality and held in mind as a relationship. These momentarily separated spatial attributes (height, width, and depth), when identified, can then be viewed as an open transparent framework of the essential spatial aspects of simple or complex material bodies. In figure drawing, quantitative extension (length), as an abstraction from human form, may be measured from the significant limits of major organic anatomic structures (the length of the leg from knee to ankle, for example).

By viewing forms as visually measurable quantities (dimensions), those immediately perceived and insistent sensuous qualities (color, value, shape, and texture) are set on a second, more manageable level. The concept of a separate and independent three-dimensional spatial quantity then becomes the first aspect of form to consider.

In actual drawing practice, one reverses the order of direct perception. What is seen (sensed) first is set down second, and what is deduced secondarily is the first thing drawn. For example, the guidelines in a drawing are the first things drawn (but are not the first things observed) [1-2]. This may not seem directly apparent in a completed drawing. The fact that a sketch by Rembrandt may contain, in a few pen strokes, a synthesis of spatial measure and sensuously (texturally) embellished line does not alter the order in which these are thought out: line as space (i.e., length) comes first; line quality comes second. (Line, primarily a symbol of length, may be adorned with implied qualities, usually value and texture.) The fact that so much discussion of drawing revolves around line quality should not obscure the underlying essential function of line as a symbol for quantitative measurement.

Line as quantity (length) and line as quality (texture, value, etc.) are generally combined in the drawing experience by veteran draftsmen and expressed as a synthesis in drawing. There are, however, drawings in which a severe limitation is made—preparatory sketches restricted almost exclusively to quantitative relationships (the guidelines in a drawing). In figure drawing, a graphic illustration of nearly unencumbered observed dimensional measurement is the pen study *Le Joueur de Flageolet* by Jacques Villon. It is conceived as a ''spatial'' construct rather than a volumetric (solid) one. The distinction is important. As a functional, preparatory drawing it contains the bare minimum of sen-

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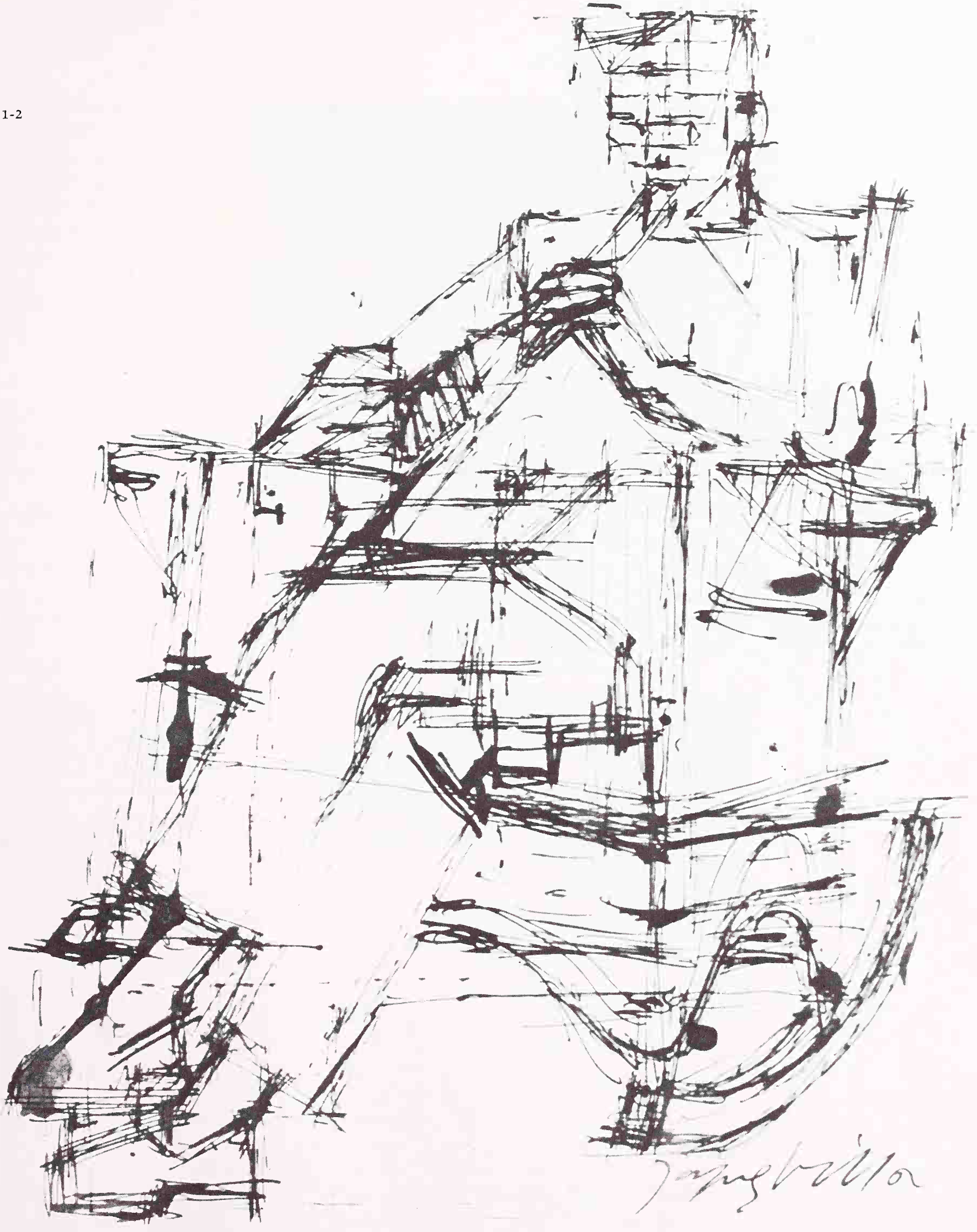

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Le Joueur de Flageolet (pen and ink, c. 1938–39) by Jacques Villon. (Collection: Mr. and Mrs. Irving M. Sobin, Boston. Photograph by Kalman Zabarsky.)

In this spatial study, line measures the space of a form but does not describe the inner surface of a volume–an important distinction in drawing. Transparent alignments of vertical, horizontal, and diagonal directions limit the area of space to be filled by forms. This is a function of guidelines in a drawing.

suous description, a spatial statement unadorned by the sentient appeal of modeling, tone, or texture. A "transparent" construct in which line functions within a firm scheme of verticals, horizontals, and diagonals, this drawing measures size, direction, and position. Its active penmanship has no specific textural focus (i.e., cloth, wood, etc.). It graphically illustrates the primacy of space (measured space) as that which precedes the development of a more substantial volumetric modeling. As a preliminary drawing, it offers a diagramed plan, a visible scaffold of open, measured structure, eventually developed into an elaborate and finished etching.

Observational drawing in its visual-spatial aspects is essentially a process of freehand space measurement. In this respect, it has a clear relation to geometry and perspective.

PERSPECTIVE AND SPACE

Quantity (i.e., length) as a visually abstractable spatial concept is related to perception in depth. In the visual arts, it has been given diagrammatic identity by the science of linear perspective. Artificial linear perspective presents the possibility of representing depth on a two-dimensional surface in a simplified schematic fashion, employing lines and (vanishing) points. It deals with forms in space as perceived by the eye (forms reduced in size, the greater the distance from the observer).

Perspective, as a pure theoretical construct, does not concern itself with qualities. A pure outline drawing of a house in linear perspective offers no evidence of its material substance, color, texture, value—in a word, no evidence of its visible, sensible qualities.

Formal perspective theory, as an aid to drawing, has dealt adequately only with very regular geometric forms and form relationships. It is related to freehand drawing, but it has not been convincingly linked to figure drawing and complex anatomy in a way that is functionally useful. (See the reference to Jean Cousin in chapter 2, page 40.) Yet the symbols of geometric perspective—the plane, the line, and the point—have a bearing on freehand form structure that is of vital consequence if vision in drawing is to develop any degree of sophistication.

The principle of space structure as the visually measured location of height, width, and depth (within a form), while easily grasped in theory, is widely ignored in practice, carelessly confused with light and shade, and lamentably misunderstood in the context of intricate human anatomy. Since it can be masked in an infinite variety of ways by complex anatomic and visual phenomena, its discovery within forms requires close examination.

Historically, the principle of three-dimensional structure derived from descriptive geometry (i.e., perspective) is the cornerstone of early Renaissance pictorial space. Vasari, in his life of Masaccio (c. 1401–1428), observes how this artist was the first (through foreshortening) to draw figures standing flat on their feet, correcting the old medieval manner in which figures seem to stand on the tips of their toes. Masaccio's ability to foreshorten forms coincided with his learning in formal perspective, discovered and communicated to him by his architect friend Brunelleschi. (Apparently, Brunelleschi did not present his ideas in a written text, but in the form of drawn and painted diagrams. Alberti developed the first text based on the ideas of Brunelleschi.)

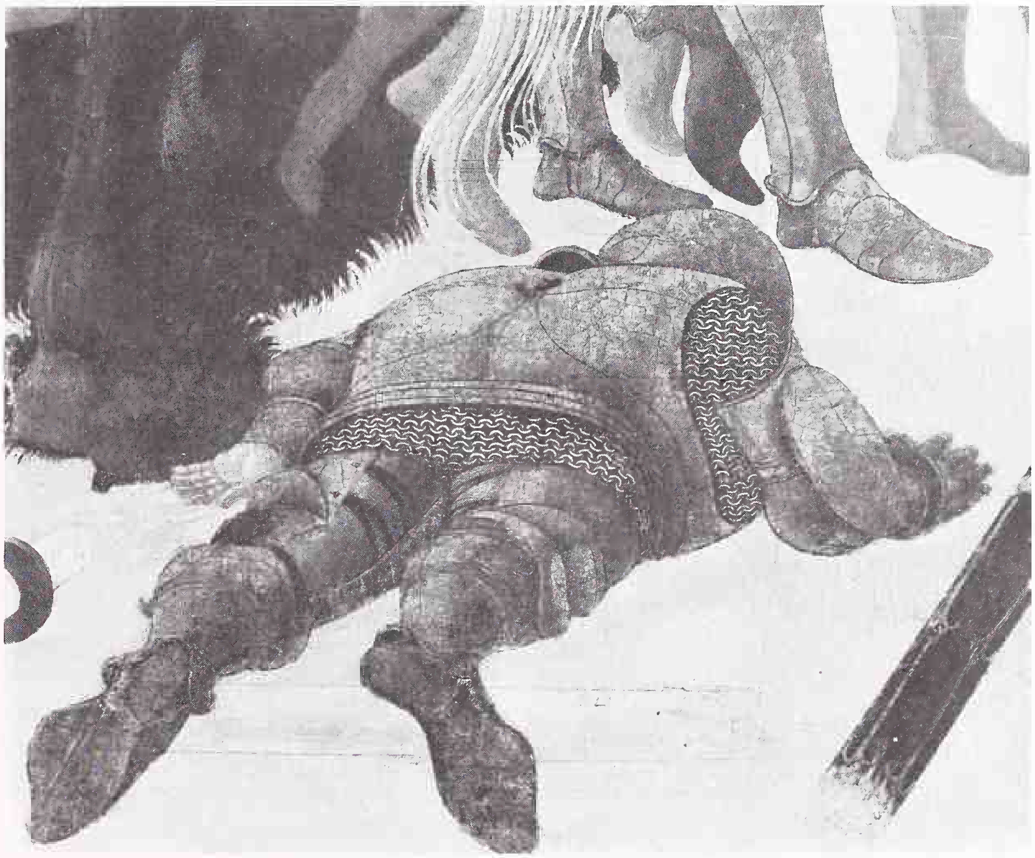
Masaccio was the first to shake off completely all medieval limitations in figure drawing. Following the instructive lead of Brunelleschi and Alberti, early Renaissance draftsmen like Uccello and later Mantegna, fascinated with the new science of perspective,

1-3
Detail from The Rout of San Romano by Paolo Uccello. (Courtesy: The National Gallery, London.)

This early Renaissance example of foreshortening in the human figure shows the influence of perspective.

1-4
The Dead Christ (oil) by Andrea Mantegna. (Pinacoteca di Brera, Milan.)

This well-known painting may be studied as a moving and dramatic exercise in foreshortening by a master of Renaissance perspective.



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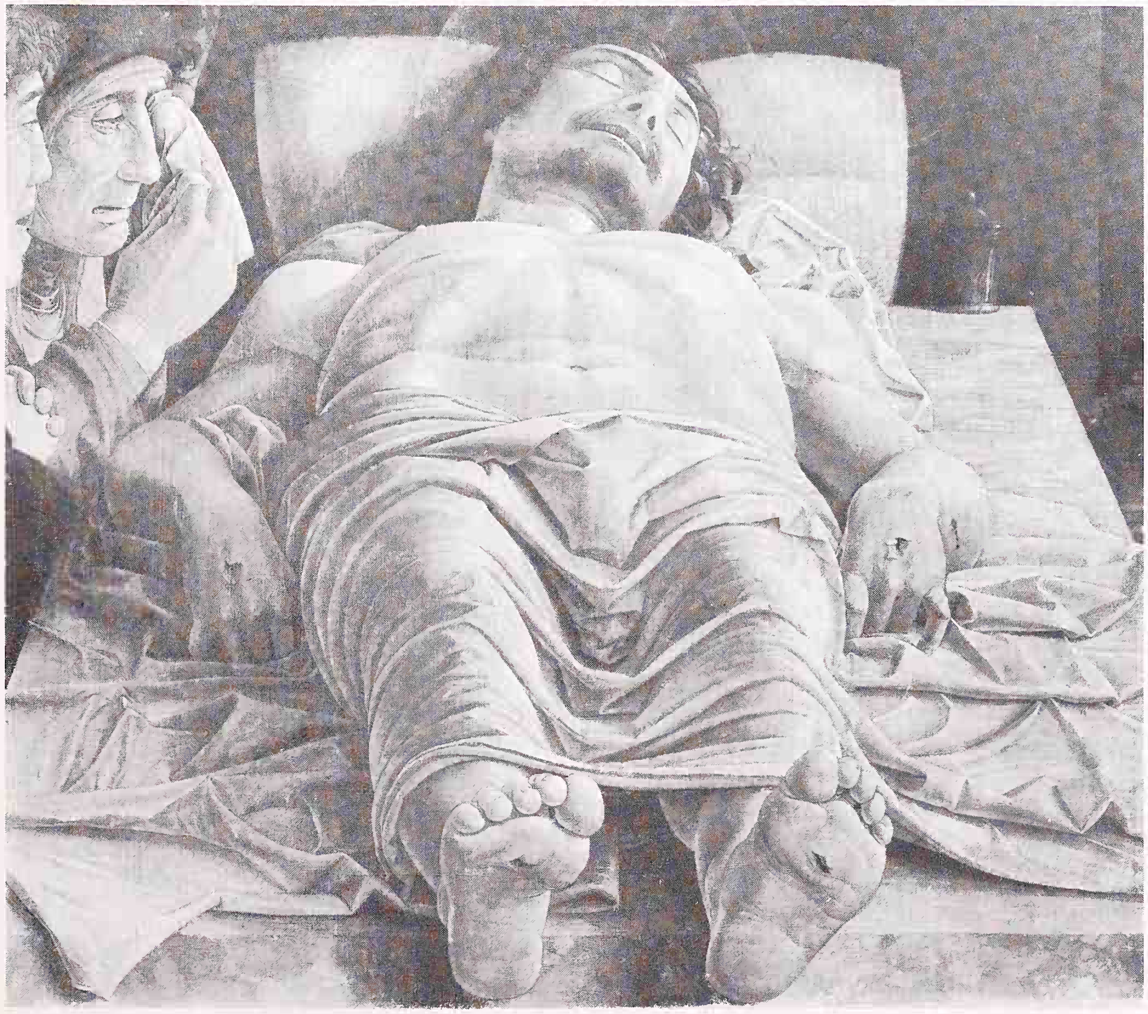

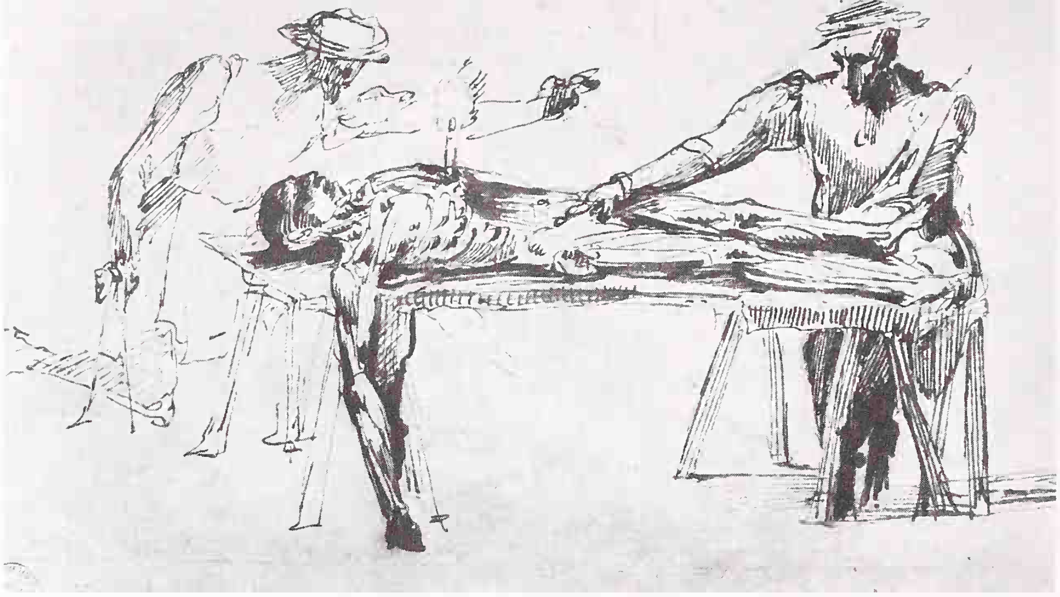

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Study for Anatomy Dissection By Bartolomeo Manfredi. (Courtesy: Ashmolean Museum.)

The science of human anatomy developed rapidly during the Renaissance, encouraged by youthful and original investigators like Andreas Vesalius. The Renaissance artist was an eager student and participant in this study of the human figure.

gave an obvious perspective emphasis to figure structure. Their forms, while convincing, are dependent on an invented space carefully directed to vanishing points [1-3, 1-4]. With the rapid and extended investigation by Renaissance artists into anatomy and drawing, it was discovered that the intricacy of human forms required a correspondingly suitable and adaptable framework for figure space more related to direct observation and capable of spatial consistency [1-5].

How was spatial order in the figure to be maintained without confusion, while accommodating the growing complexity of anatomic information observed in the human form? The genius of the Renaissance artist found the answer with apparent ease and expressed it in drawing as a spatial construct, an informal perspective, freely adapted to observation. This concept has continued to be an underlying (often tacit) influence in Western pictorial vision.

A clue to the solution of the problem of structure is offered by Leonardo da Vinci in his *Paragone*, where he defined the nature of the artist's space: "The science of painting begins with the point, then comes the line, the plane comes third, and fourth the body in its vesture of planes. This is as far as the representation of objects goes. For painting does not, as a matter of fact, extend beyond the surface and it is by these surfaces that it represents the shapes of all visible things."[2] The geometric derivation is from Euclid's *Elements:*

1. A point is that which has no parts. (A point has position but no dimension.)
2. A line is breadthless length.
3. The extremities of a line are points.
4. A straight line is a line which lies evenly with the points on itself.
5. A surface is that which has length and breadth only.
6. The extremities of a surface are lines.

The translation of these geometric concepts into the sensuous experience of freehand observational figure drawing has not been, to my knowledge, clearly or extensively developed in a drawing text. Leonardo, in his book on painting, did not outline the procedural implementation of his definition in the *Paragone*. Although he made many references to mass and volume and to the perspective of whole bodies diminishing in size in a common space, he did not clarify or develop the use of space measurement and locational relationships in detailed freehand drawing of the specific parts of the figure form. Yet, in practice, it has been part of a visual language of enormous significance in dealing with complex irregular forms and the basis of what may be termed space structure in Western European (post-Gothic) spatial drawing.

Forms, to be fully understood, must be reduced to their constituent planes. Conceptually, in a geometric sense, there is a further reduction of the plane to its limiting

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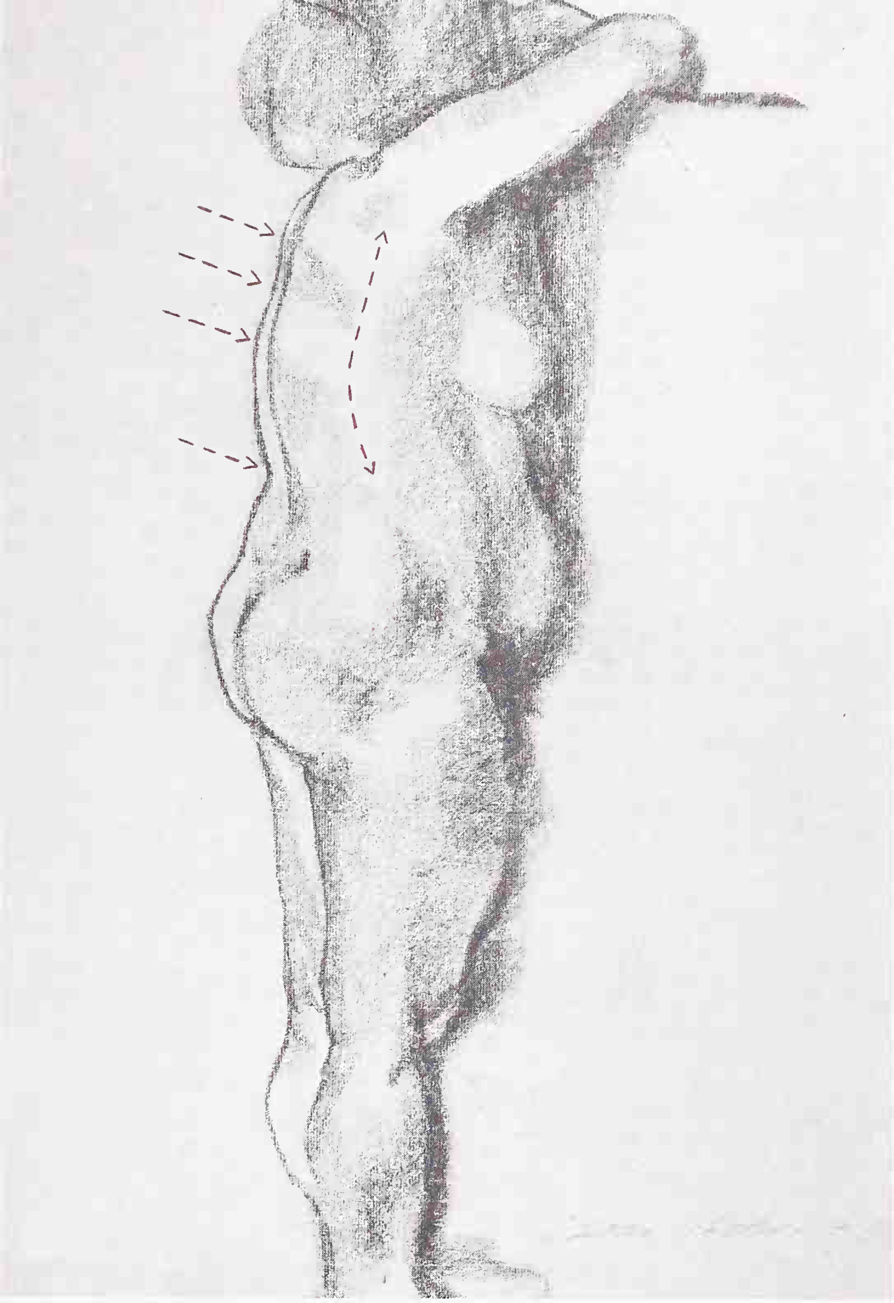
[2] Irma A. Richter, introduction and English translation, *Paragone, a Comparison of the Arts, by Leonardo da Vinci* (New York: Oxford University Press, 1949), p. 24.



1-6

edges (lines—the equivalent of length) and connecting corners (points—the equivalent of position).

The geometrician's concept of line and point is a pure nonmaterial abstraction. A line as pure length has no thickness. A pure point has no dimension (but it can be understood as location). Piero della Francesca in his treatise, *De Prospectiva Pingendi*, translates the geometrically conceived abstract nature of line and point to the practical needs of the draftsman: "A point is that which has no parts, and according to what the geometricians say, is only in the imagination. A line, they say, has length without breadth and because of this is apparent only to the intellect. But I say that in order to discuss perspective with demonstrations, which I wish to be comprehended by the eye, it is necessary to give another definition. Therefore I say, a point is a thing as small as it is possible for the eye to comprehend. A line, I say, is an extension from one point to another whose breadth is of the same quality as the point. Surface, I say, is width and length enclosed by lines . . . ."[3] In graphic representation, the conventions of line and point (implied or drawn) are necessary to give objective identity to surface limits in drawn forms.

Tonal drawings such as those by Seurat, Prud'hon, Menzel, and Kollwitz seemingly depend on a broad expanse of modulated value only. But their spatial strength rests on a point location structure inherent in angular changes in the silhouette and identifiable related lengths running into the form through a tone. A field of value gradation or shadow tone (carefully observed) has a structurally functional limit [1-6].

1-6

Standing Nude (charcoal) by Kathe Kollwitz. (Collection: Mr. and Mrs. Irving M. Sobin, Boston. Photograph by Barney Burstein.)

Accurately conceived tonal drawing is a means of defining structure. Contour changes of direction (in the silhouette) are carefully related to changes of planes within the form. These are expressed by carefully observed tones (values) extending into the inner surface. The vertical highlight on the inner torso follows the larger contour curve of the back, showing a surface change from the back, to the side, to the front of the body.

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[3] Elizabeth G. Holt, *Literary Sources of Art History: An Anthology of Texts from Theophilus to Goethe* (Princeton: Princeton University Press, 1947), p. 156.

1-7

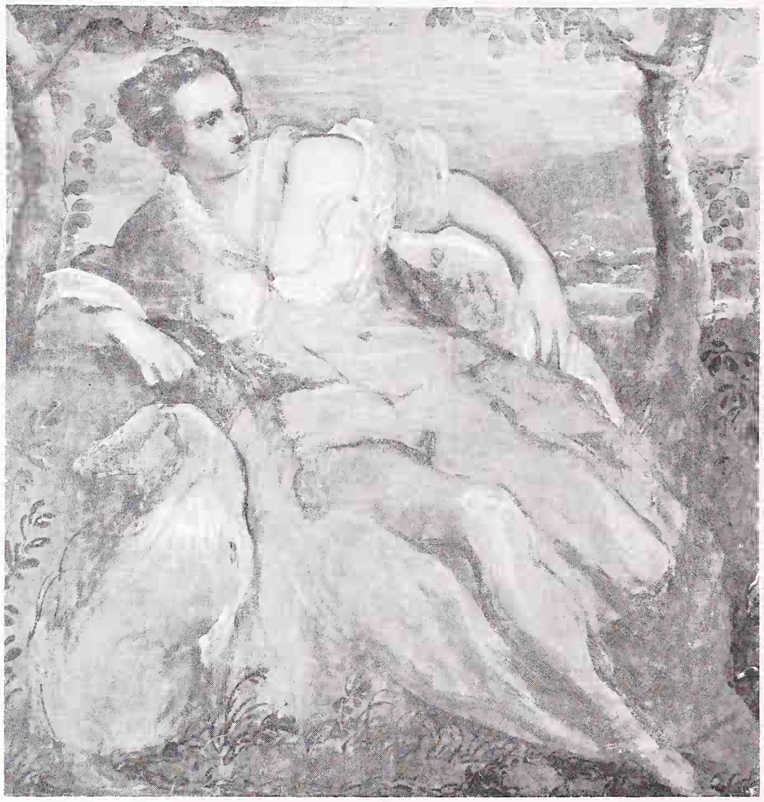
The Symbols of Space.

In an abstract sense, the symbols of perspective (lines and points) identify important aspects of space. Lines identify direction and length; points identify location. Graphically, the breakdown of a simple form to its geometric constituents is: plane—to line—to point. In drawing, the point (the unit that has position in space) is the essential useful resource. Terminal locations (points) abstracted from more complex forms (i.e., the human figure at its bony articulations) are a means of understanding its spatial order. In a simple block, the corners can be abstracted and symbolically located as points. Their position is important in conveying the idea of a block.

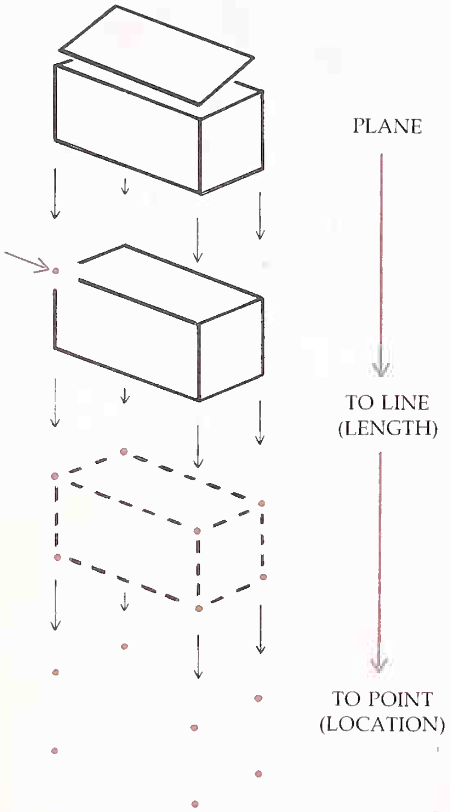
1-8

Allegory of Fidelity (oil on canvas, 1570–80) by Tintoretto. (Fogg Art Museum, Harvard University; Gift of Mrs. Samuel Sachs in memory of Mr. Samuel Sachs.)

In this unfinished canvas by Tintoretto, selectively precise brush drawing is revealed in the underpainting of the legs, setting up large plane relationships. (For details, see illustrations 1–9,1–31, and 6–44.)



1-8



1-7

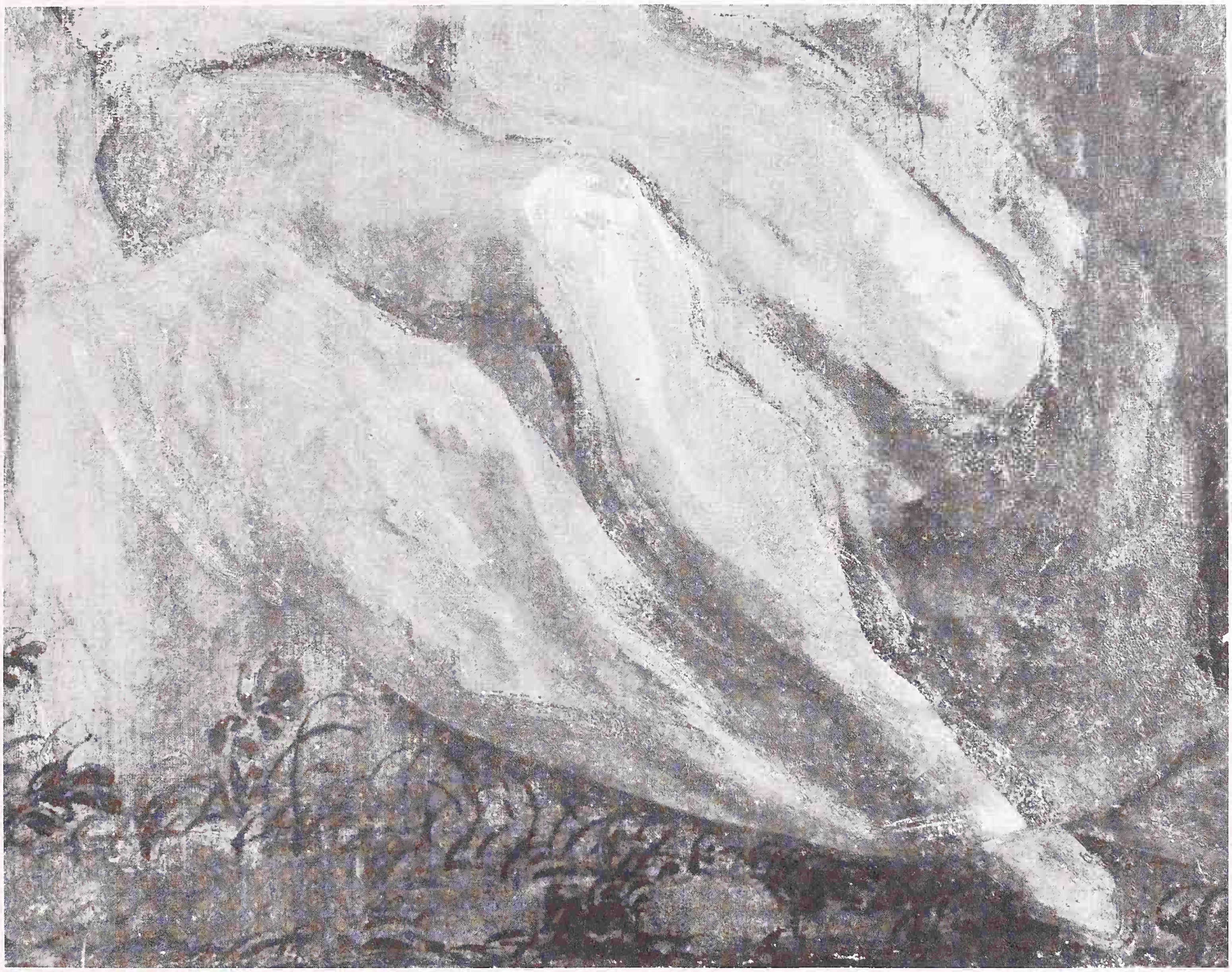
The space structure within volumes is here understood to be the visually measured relationship at the juncture of two or more plane surfaces. Since connecting planes are limited by corner points common to both planes, the elimination of connecting lines (i.e., edges) leaves the points in an established position in space (see figure 1-7).

In drawing, the point (the unit that has position) is clearly the most fundamental space symbol. In establishing drawn spatial relationships, it is the essential resource. Structure is stated primarily by relationships of location, not by linear or modeled connections. It is the measurement of that portion of space occupied by the form rather than the form itself (quantity stripped of substance). Its function is to establish with precision the positions of height, width, and foreshortened depth within a volume. As part of a fundamental freehand geometric perspective, it deals largely (though not exclusively) with foreshortened forms.

Structure as an order of positioned relationships may be graphically represented by the point, but in practice, as a symbol for location, the point is rarely stated directly. It is generally held in mind and functions as a concealed, implied element in drawing.

Position or location within a form is important in communicating a visual idea. A simple block is identified by a relationship of its corner limits (represented by points) carefully calculated by observation [1-7]. If this relationship is not attentively observed (or is deliberately altered), another quite different visual idea (form) will result [1-10].

In drawing the human form, the very same locational considerations are important. In the leg a similar blocklike structure, but organically more complex relationship, exists. Complexity can distract attention away from a fundamental spatial order. As a result, the positions of limits in an intricate human form—at the knee joint, for example—are often carelessly noted. Consequently, even though the leg may be carefully and persuasively modeled, the drawing will seem spatially flat. The difference may be illustrated by the detail from the Tintoretto figure [1-9] and altered in the accompanying drawing [1-10].



1-9

1-9

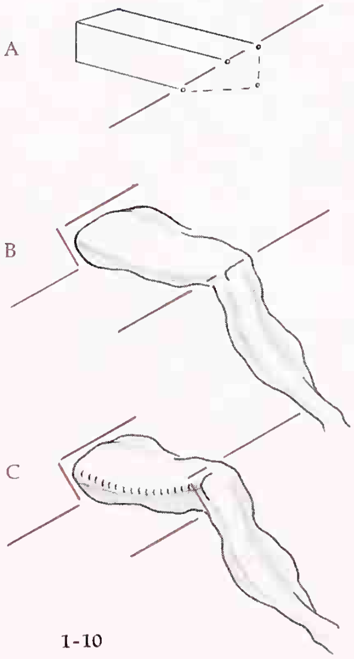
Detail from Allegory of Fidelity by Tintoretto.

The locational limits in the knee articulation are strong and spatially convincing, like the corners of the block in illustration 1-7. A frequent error in drawing is illustrated in the diagramed sequence (1-10) based on this detail.

1-10

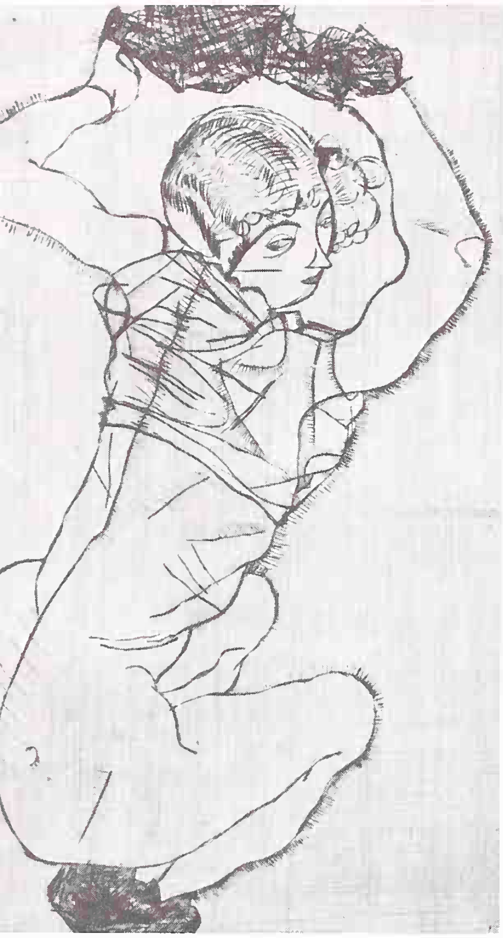
Distortion of Space.

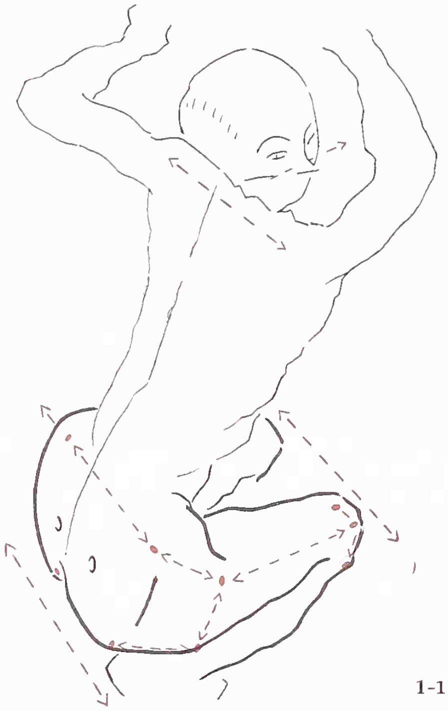
A frequent error in drawing is illustrated based on the leg detail (1-9) from the painting by Tintoretto. In figure *A*, the inaccurate location of corners flattens two right-angled planes. This is obvious in a simple block. The same distortion is frequently overlooked in drawing from the human figure. Though convincingly modeled, figure *B* contains the above spatial contradiction. In figure *C*, the right angles at each end of the form explain the planes that make up the volume. The position of the kneecap above the lower contour contains the full dimension and direction of the side plane in relation to the top plane of the leg.



1-10

1-11





1-12

When location is noted carefully, the modeling is reinforced, and space and modeling are consistent. With experience, when forms are fully understood, often little or no modeling is required. A great deal of information is compressed within a few related lines and cogently, convincingly implied [1-11]. It should be stressed that a drawing of this latter kind is the result of close study and long experience.

If one considers spatial ideas in terms of locational relationships, a more precise synthesis of anatomy and form is possible [1-12]. Positions are observed with care and can be identified with specific skeletal or muscular units. The problem is still a difficult one. Planes in the figure are not limited to simple or obvious right-angle relationships as in the above examples. They are varied and complex, set at many subtle angles, and fluidly merging, one with another within a form unit.

Intricate anatomic structures can easily obscure significant fundamental relationships. For purposes of space explanation in freehand drawing, the nature of point-location must be broadly interpreted. In the figure, smaller anatomic entities (a round bone or muscular eminence) can serve as a structural limit (i.e., a geometric point).

The point is a convention and a convenience, a mental symbol for the location of visual positions within a relationship. In a drawing it is embodied in the order of parts that make up a plane and that relate plane to connecting plane in a representation of the full three-dimensional volume. In figure drawing, the point may be used as an abstract symbol for the precise position of a part of human anatomy—in effect, a temporary mental (or graphic) stand-in.

Ideally, space within a volume may thus be conceived as an abstracted scaffold of associated locations (height, width, and depth) which may be represented by the geometric concept of a point. Whether graphically stated or held in mind, the point identifies a single factor only: one positioned limit of a visually measured extension of surface. It is an element clearly distinct from patterns of light and shade on a form. This should be emphasized. While light is an obvious necessity to vision, the interpretation of significant clues on a lighted form aims to identify surface areas beneath tonal modulations.

By its abstract and neutral character, the located point can define spatial limits in any and all forms without influencing expression, style, or technique. It can be uniquely useful in giving spatial order to complex anatomic relationships in figure drawing. Structure provides support for expression. The function of this geometric symbol (the point) is to aid the artist to hold in mind a framework of locational limits; first in their widest order and distribution within an overall form, and then proceeding to smaller related parts.

The initial selective isolation of important locational limits in the human form is abetted by the knowledge of important bone relationships at the extremity of a form. The Raphael study [1-13] is a good example. In the drawing of the bent elbow, three points of location are inherent—in the two epicondyles of the humerus and the olecranon process of the ulna. They set the order of planes that end at the wrist in a related spatial sequence [1-14]. While this space structure is more obvious where skeletal limits come directly to the surface of a form, the same analysis can be made in the more muscular and fleshy parts of the torso.

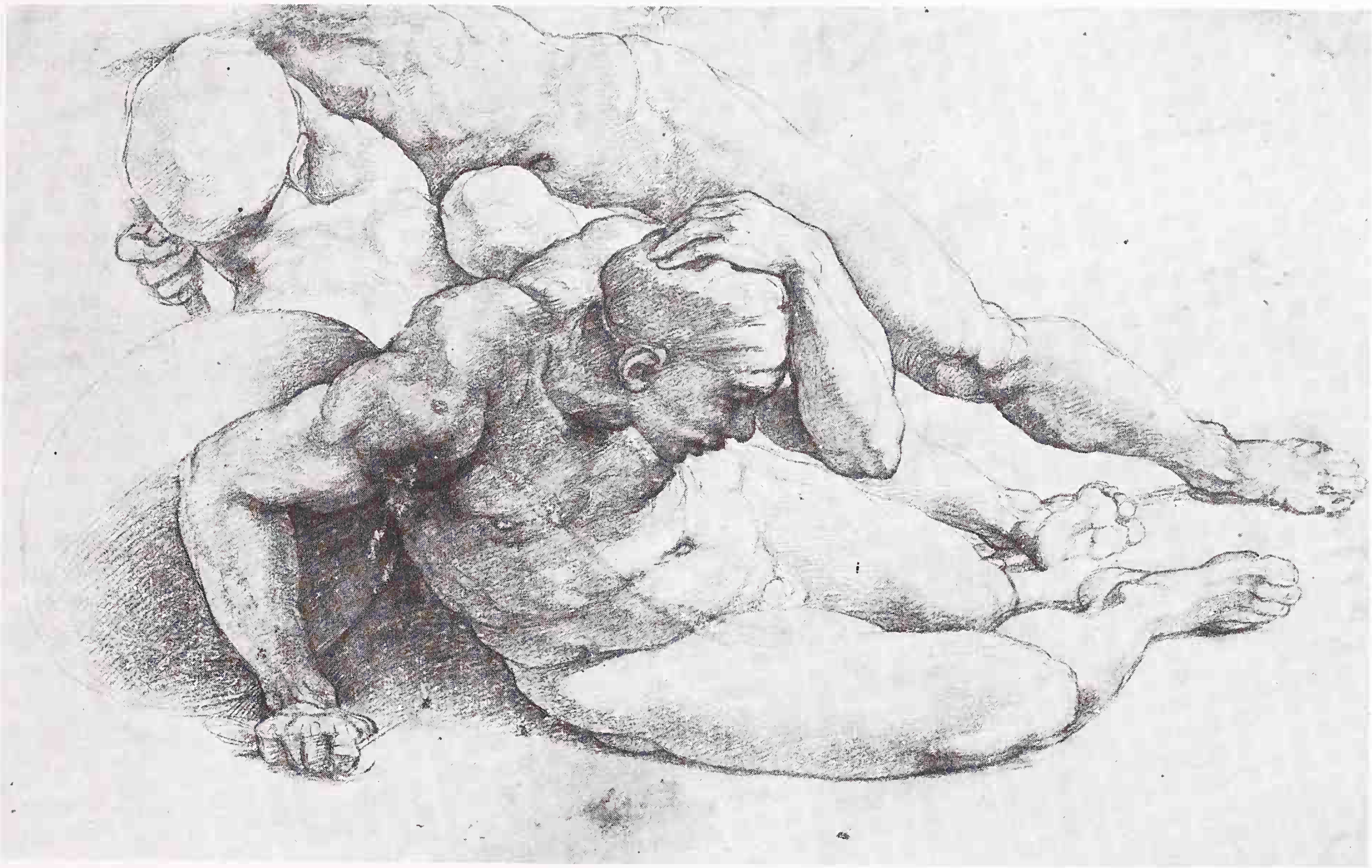
The choice of which prominences to use as a basis for significant surface structure can be determined by their utility in containing and explaining the broadest extent of surface. Thus, a wrinkle or vein on the skin occurring midway between wrist and elbow would not contribute to an understanding of the largest or broadest organic structure of surface in the forearm. It would be an unfortunate choice as a structural limit. Prominent veins on the back of the hand, for example, if copied solely as shadow pattern, destroy the sense of continuous unified surface.

1-11
Squatting Woman (etching, 1914) by Egon Schiele. (Courtesy: Galerie St. Etienne, New York.)

Perspective, space, and volume are skillfully conveyed in this line drawing. Selectively consistent location is the key to spatial order. (See the analysis, 1-12.)

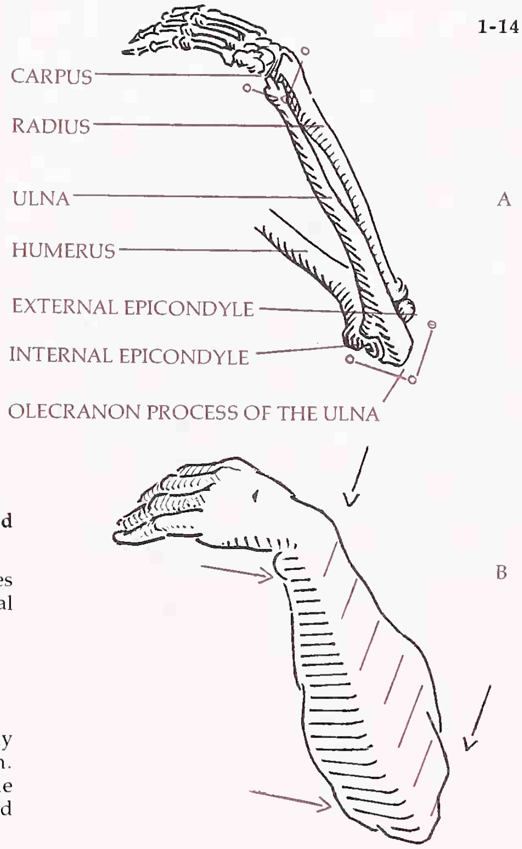
1-12
Diagram of Space.

Carefully compare this analysis of related locations within the figure with the etching by Egon Schiele. Locational structure is clear and conveys a consistent perspective.



1-13

1-14



1-13

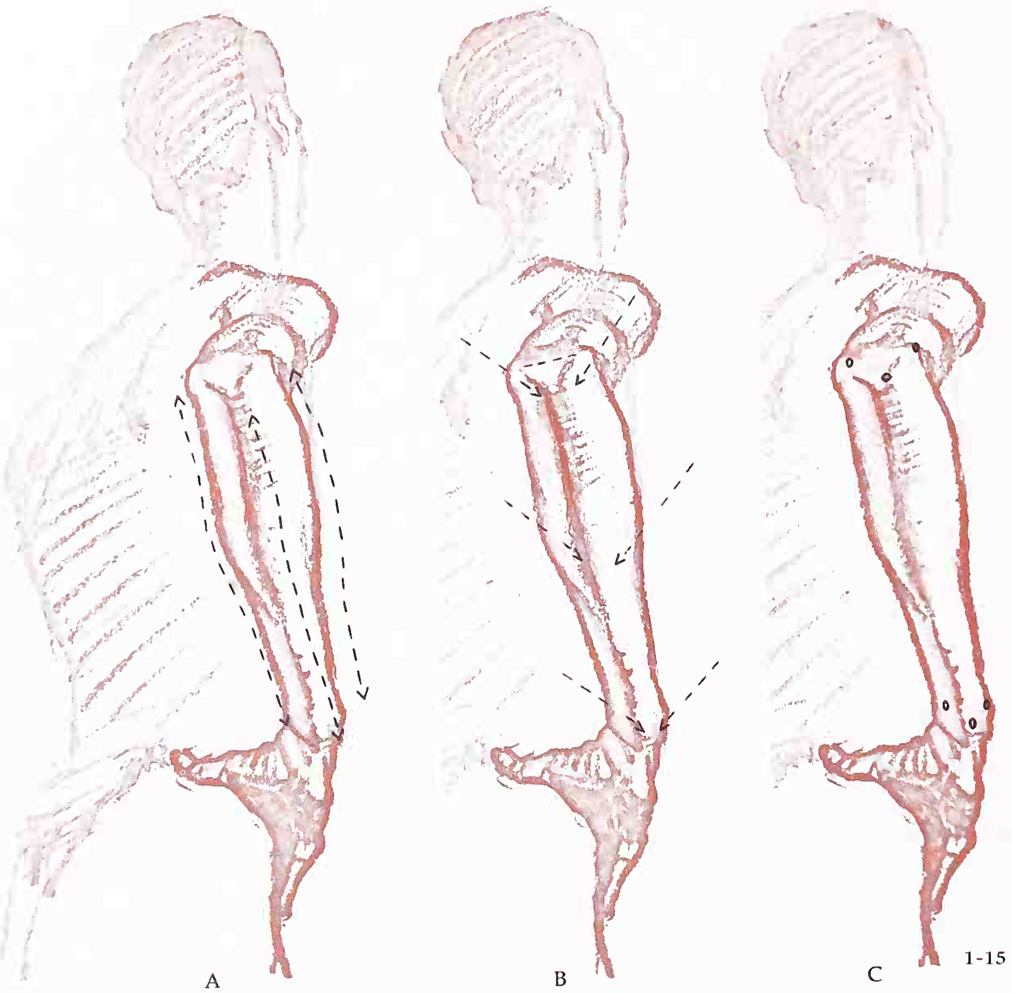
Three Nude Men in Attitudes of Terror (black chalk) by Raphael. (Devonshire Collection, Chatsworth. Reproduced by permission of the Trustees of the Chatsworth Settlement.)

The relationship of planes in the raised forearms is dependent on its bone structure. The light and dark planes join along an axis running from elbow to wrist. For an analysis of surface order and its dependence on skeletal anatomy, see the accompanying diagram (1-14).

1-14

Analysis of Skeletal and Plane Structure.

The diagram is based on the chalk drawing (1-13) by Raphael. Figure *A*: Within a long form, the position of bony prominences at the end of the volume determines the surface development within the overall length of the form. The triangular arrangement of bones at the elbow sets the direction of major opposing planes that end at the wrist. Figure *B*: A simplified diagram indicates the surface relationships from elbow to wrist. Within this broad order of two planes, smaller form units have been integrated while this basic structure is preserved.



1-15

1-15

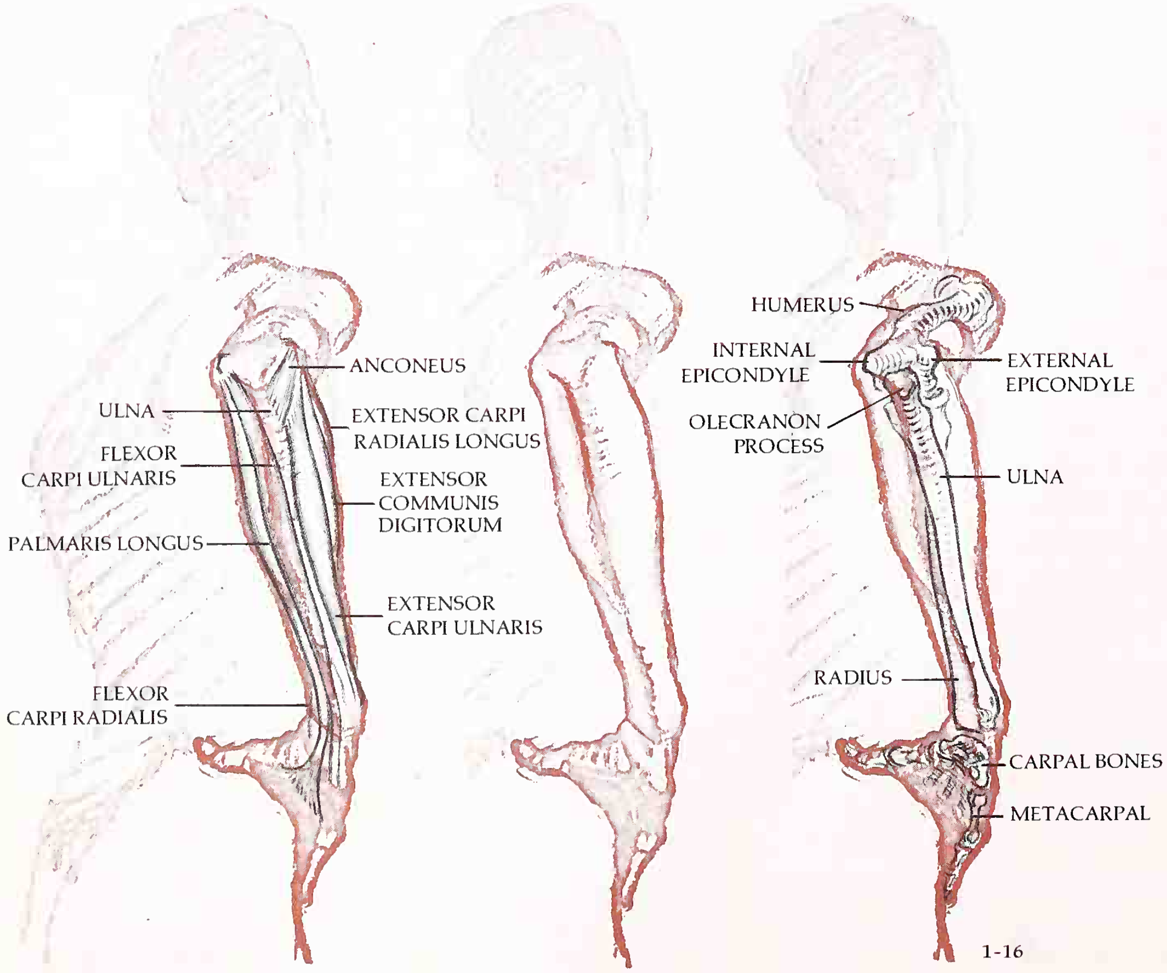
Space Analysis of an Arm by the author. (Photograph by Jonathan Goell.)

A three-stage visual analysis of an arm is reproduced to show significant relationships at each end of a form. Directions of length *(A)* intersecting with directions of width *(B)* identify the locational limits of bone at each articulation *(C)*. (This illustration and the accompanying text explanation represent an important key to the analysis of space.)

1-16

Bone Structure: Key to Space in the Figure. (Photograph by Jonathan Goell.)

Note the triangular relationship at the elbow. The two condyles of the humerus bone are the origin and the olecranon process (of the ulna) the point of contact for the two long diagonal planes that extend the full length of the forearm to related angles below. The styloid processes of the ulna and radius bones (plus muscle tendon) create a similar relationship at the wrist. These positions provide the essential structure of the modeling and refinements of surface.


ANCONEUS
ULNA
EXTENSOR CARPI RADIALIS LONGUS
FLEXOR CARPI ULNARIS
EXTENSOR COMMUNIS DIGITORUM
PALMARIS LONGUS
EXTENSOR CARPI ULNARIS
FLEXOR CARPI RADIALIS
HUMERUS
INTERNAL EPICONDYLE
EXTERNAL EPICONDYLE
OLECRANON PROCESS
ULNA
RADIUS
CARPAL BONES
METACARPAL

1-16

Understood as an abstracted relationship, space structure permits a wide variety of form and textural development from the simple line sketch to the heavily modeled or patterned drawing. In perceptual practice, it is the discernment of an abstracted arrangement of dimensions; a framework briefly lifted from its context, visually measured, then restored to its specific location in a form. Its identification does not require the elimination of complexity but demands instead a technique of initial selective visual isolation. Since numerous small curving plane surfaces can obscure the overall surface order in the figure, the uncovering of significant points of structure requires focused perception, experience, and some understanding of important surface anatomy. Difficult to discover in complex reality and generally concealed by artistic or expressive intent in drawing and painting, structure may be called the hidden language.

The following example illustrates the observational procedure involved in analyzing the space in a drawing. Of course, it must be clearly recognized that the drawing [1-15] represents the completed thought of the artist, and important selective emphasis has already been distilled from reality. Reading the space in the drawing is not the same as facing the myriad complexities of the living, moving model. But the means of identifying fundamental structure is essentially the same. To ''uncover'' the explanatory spatial structure in this detail of an arm (in this case, a long form): (A) related directions of length are identified running parallel or nearly parallel through the length of the form (as in the contours and the direction of shadow from elbow to wrist); (B) related directions of width moving in from both long contours at the elbow and wrist are noted (which may be parallels or near-parallels running into the center of the volume from the contours); (C) where directions of length intersect directions of width at the end of the form (the articulations), the limiting angles (points) of surface are identified and located as a basis for the description of surface and volume.

This indicates an essential order. With practice, it may be held in mind as an abstracted construct on which the forms are drawn. Explanation of complicated, overlapping forms is dependent on the specific anatomy of muscles, related to bones [1-16]. Part two of this text develops this relationship.

DIRECTION IN DRAWING

Direction in drawing is closely tied to location and length. Simply understood as the movement between two locations, it may be vertical, diagonal, or horizontal. (The degrees of diagonal are countless.)

Direction, as the major action or gesture of the figure, is an initial important concern in drawing. As a primary spatial factor it seldom receives the full consideration it deserves and is open to easy misrepresentation. It can only be successfully established in the first stages of a drawing. Therefore, ample time should be allowed to make careful, accurate judgments of the chief actions. Precise comparison of the figure with an adjacent vertical—a door frame or the vertical corner of a room—is a convenient, useful aid in discovering the main axis of a form [1-17]. When there is no neighboring vertical, a pencil (or other drawing implement) can be held firmly at arm's length on the line of sight with the figure and will perform this same function.

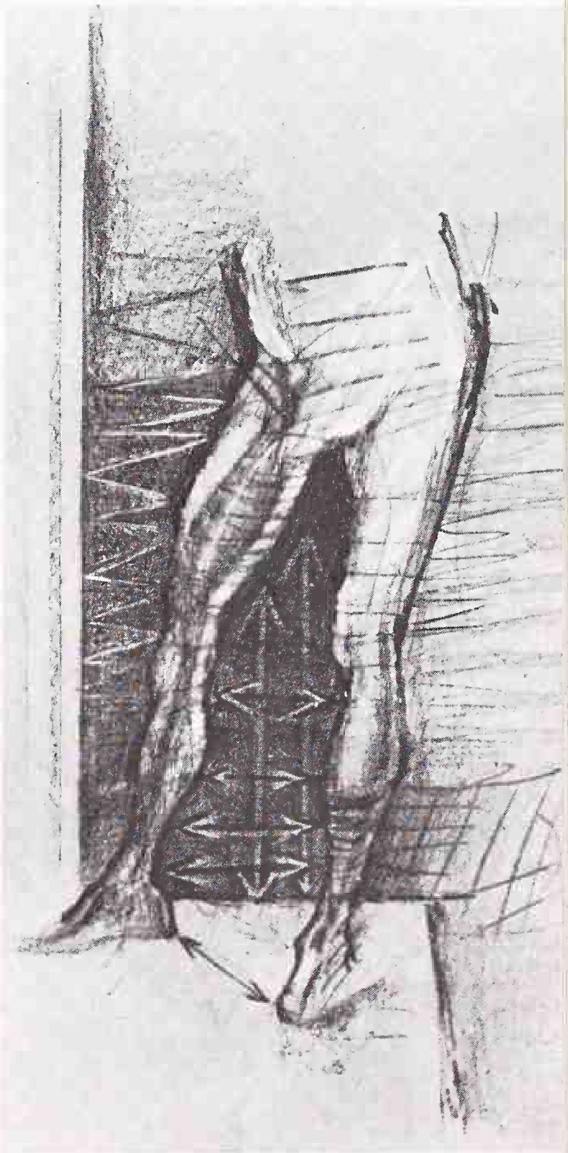
Quick gesture drawing may help the student grasp large actions and relationships, and it does stimulate an alert frame of mind. But gesture drawing also opens the possibility of self-deception. The spontaneous but imprecise, inaccurate movements of the crayon on paper are often a substitute for the true and convincing action of the figure. The rapid crayon marks may have a superficially attractive sense of movement but no relation to

1-17

Direction and Figure Gesture. (Photograph by Kalman Zabarsky.)

The gesture of the figure may be accurately observed by comparing the directions in the figure with a nearby vertical (or horizontal) direction. Arrows and zigzag white lines illustrate graphically the movement of the eye carefully viewing divergent directions acrosss an open space.

1-17



1-18

Study of the Man Standing, Seen from the Back **(charcoal) by Edgar Degas. (The National Gallery of Canada, Ottawa.)**

In this study the figure is seen from the back; the left leg is raised and the left elbow rests on the knee. A too-narrow focus on small individual irregularities of contour frequently obscures long directions and major changes along the edge of a form. In this early study by Degas, significant contour changes have been precisely observed. Smaller irregularities have been compressed, but not lost, within the sequence of longer movements (i.e., angular changes at the ankle, calf, and hip in the extended leg.)

1-19

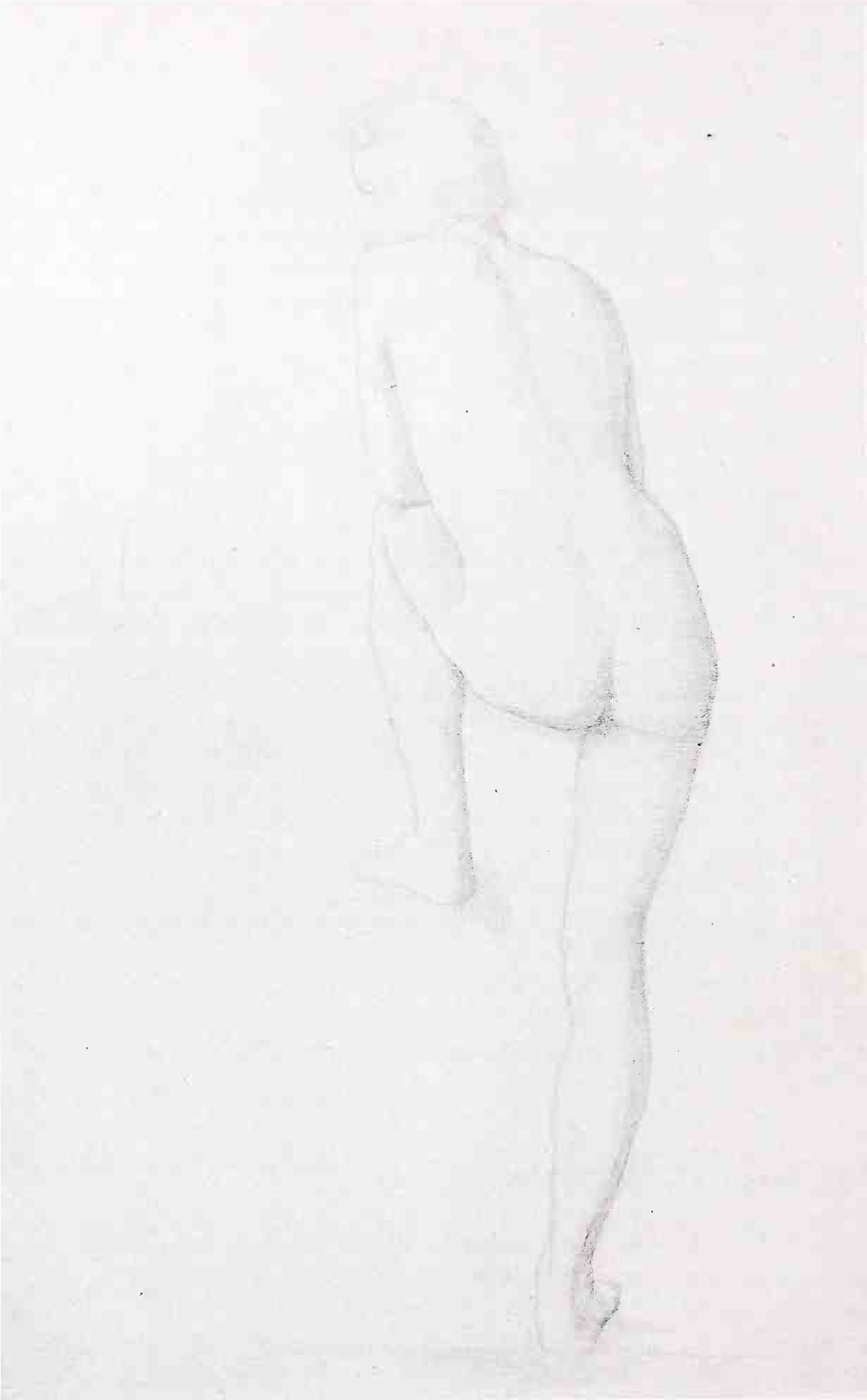
Lucretia **(black and white ink) by Albrecht Dürer. (Graphische Sammlung Albertina, Vienna.)**

Rounded volumes with subtly continuous curved surfaces can reveal structural clues through an understanding of the articular connections of the skeleton. The bony projection at the hip (great trochanter of the femur) unites two opposing directions above and below. (See the accompanying diagram [1-20].)

1-20

Diagram from Lucretia.

The identification of a structural limit in subtly curving forms. The "peak" of the curve in the rounded hip is determined by the projecting great trochanter of the femur bone. This prominence affords a structural limit.



1-18

the actual gesture. With careful observation, however, gesture studies may help to focus attention on the larger actions and dimensions of the figure.

Students who have experienced the alert attention inspired by quick poses should remember that this same alertness can and should be sustained in longer studies of the figure. Drawing is not a passive, mindless activity of mechanically recording the shadow-shapes on a form or a series of meaningless linear bulges on a contour.

Direction in drawing is paramount in planning the large disposition of related forms. It also is an important consideration in the refinement of surface relationships within forms—that is, the direction along the margin between adjoining surfaces. These occur, often with great subtlety, throughout the figure. An easy-to-see example is the exposed shaft of the shinbone (tibia), which follows a continuous direction from the knee to the inner ankle. Two planes of the front of the lower leg join along this curved direction. (See illustration 1-30.)

Structure in relation to the subtlety of curved forms and contours requires special comment. Curves and angular changes in contour should be noted with great care in the figure. All curves are not the same, though in drawing they are often carelessly assumed to be. They vary enormously from long, open crescents to short, hooklike arcs. A sharply constricted contour curve may serve functionally as an angle (point limit) in describing a change of plane. Directional changes in a contour, which at first glance may seem easy and fluid, can be compressed to an almost angular opposition of direction. The early, largely linear, study by Degas [1-18] accounts for numerous small variations kept subordinate to larger, precise contour "breaks." The contour of one side of a form is carefully related to the contour of the other side of the form.

Long contour lines and precise angular changes may be camouflaged by small irregularities. Care should be taken to keep these smaller contour irregularities from overpowering and obscuring major breaks in direction. The Degas drawing presents a good, disciplined example of small irregularities compressed to emphasize main contour movements.

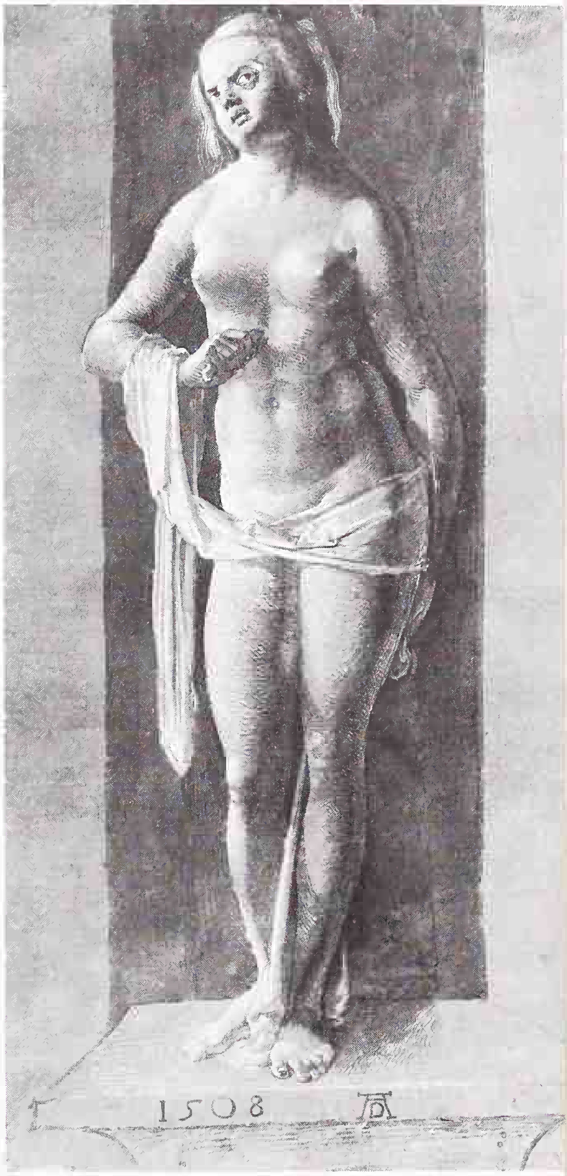
The relation of point location as an internal structural element in rounded volumes has also to be considered. In this instance, complexity and asymmetry aid the draftsman. The organic irregularity of forms or, more accurately, the interplay in the figure between curved and angular relationships prevents an absolute perfection of geometric volume. Rounded forms in the figure are not purely round, and, in addition, they intersect with adjacent forms. The intersecting connection between two form units creates an angle of different directions and thus provides the location of a structural limit.

In the female form, in which rounded volumes generally dominate, angular connections occur between round forms as well as between flat planes. In the drawing by Dürer [1-19], the almost pure conical form of the thigh intersects at the hip with a long vertical angle [1-20]. Again, the connecting relationship at the end of the form (usually a bone) clarifies the surface definition through the length and mass of volume.

In continuous irregular surfaces which, in many parts of the figure, extend from one bony limit to another, there are angular changes. These often are subtle in curvature and may encompass subordinate points within their surface areas. These subordinate softer, muscular surface transitions, while they should be observed carefully with respect to structure, can generally be emphasized less than the articular limits of form, which more often are hard and skeletal. A strict flattening of rounded surfaces can result in excessive geometricising in a rigidly mechanical fashion. A qualification is in order here.

Though there may be a temporary danger of fragmentation and disunity, it is helpful to identify changes in the direction of a curve by reducing it to faceted sections along its curved length. This sharpens observation. When this has been accomplished in the context of other relationships, and the character of the curve is understood, faceted units can be reintegrated into a fluid and unified curved plane and contour. Jean Dominique Ingres stated: "Beautiful forms are straight planes rounded."

In drawing, visual sensitivity to hard bony surface in relation to softer fleshy form should help to avoid the danger of making repetitious and mechanically meaningless facets. Proceeding, say, from the elbow to the wrist, the rounder egglike fleshy part on the upper forearm develops into the blocklike bony and tendinous form of the lower forearm (just above the wrist). The transition from bony surface to fleshy form should be carefully noted in dimension and direction.



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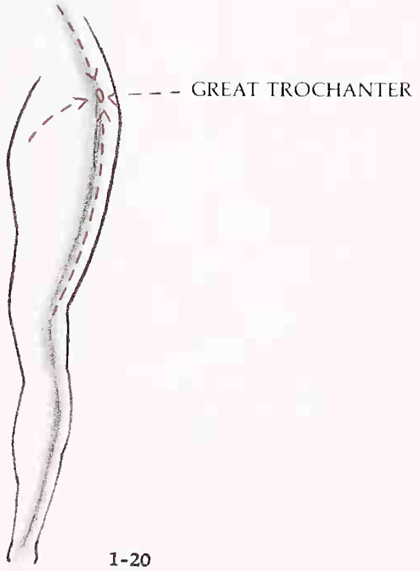

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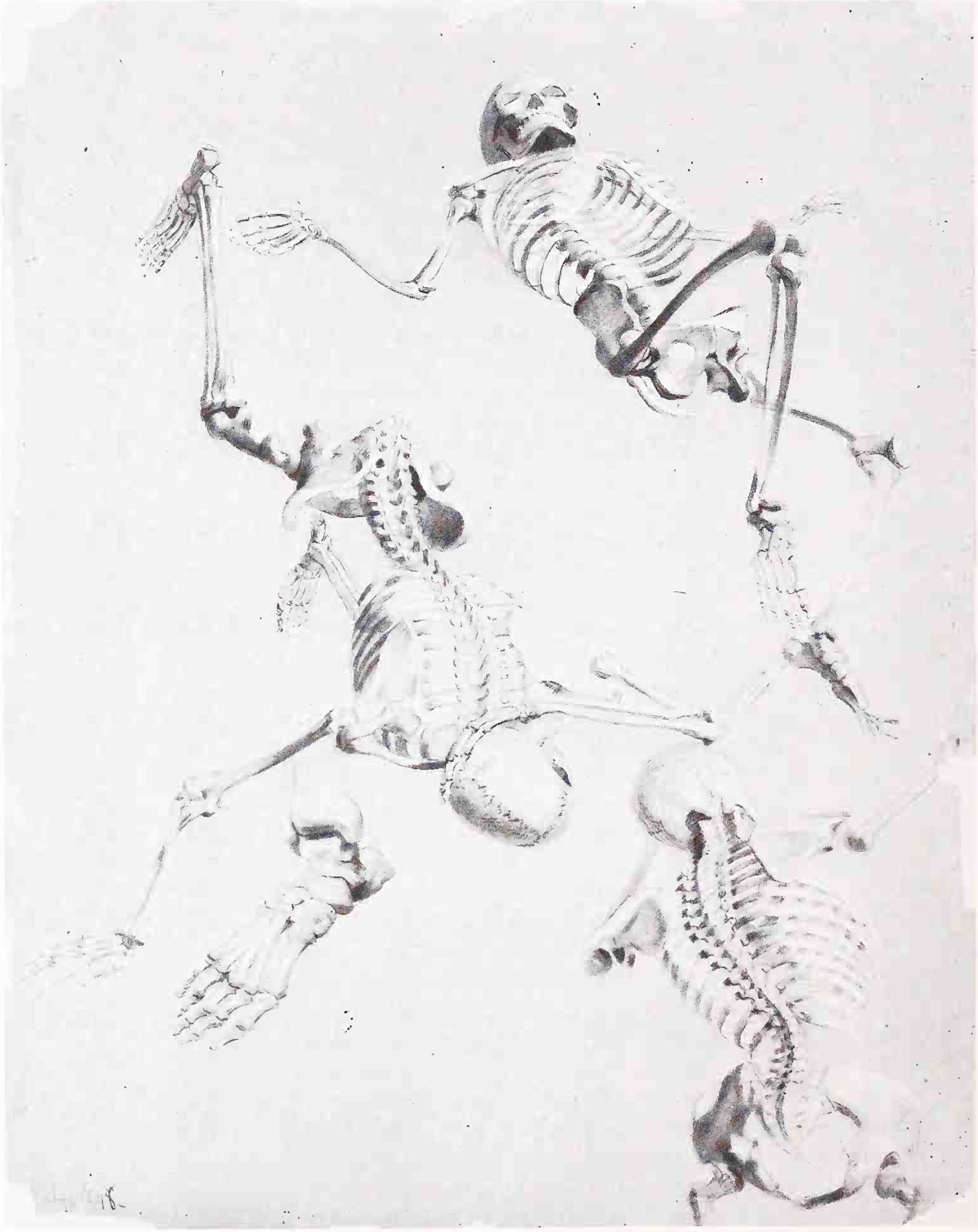


1-21

1-21

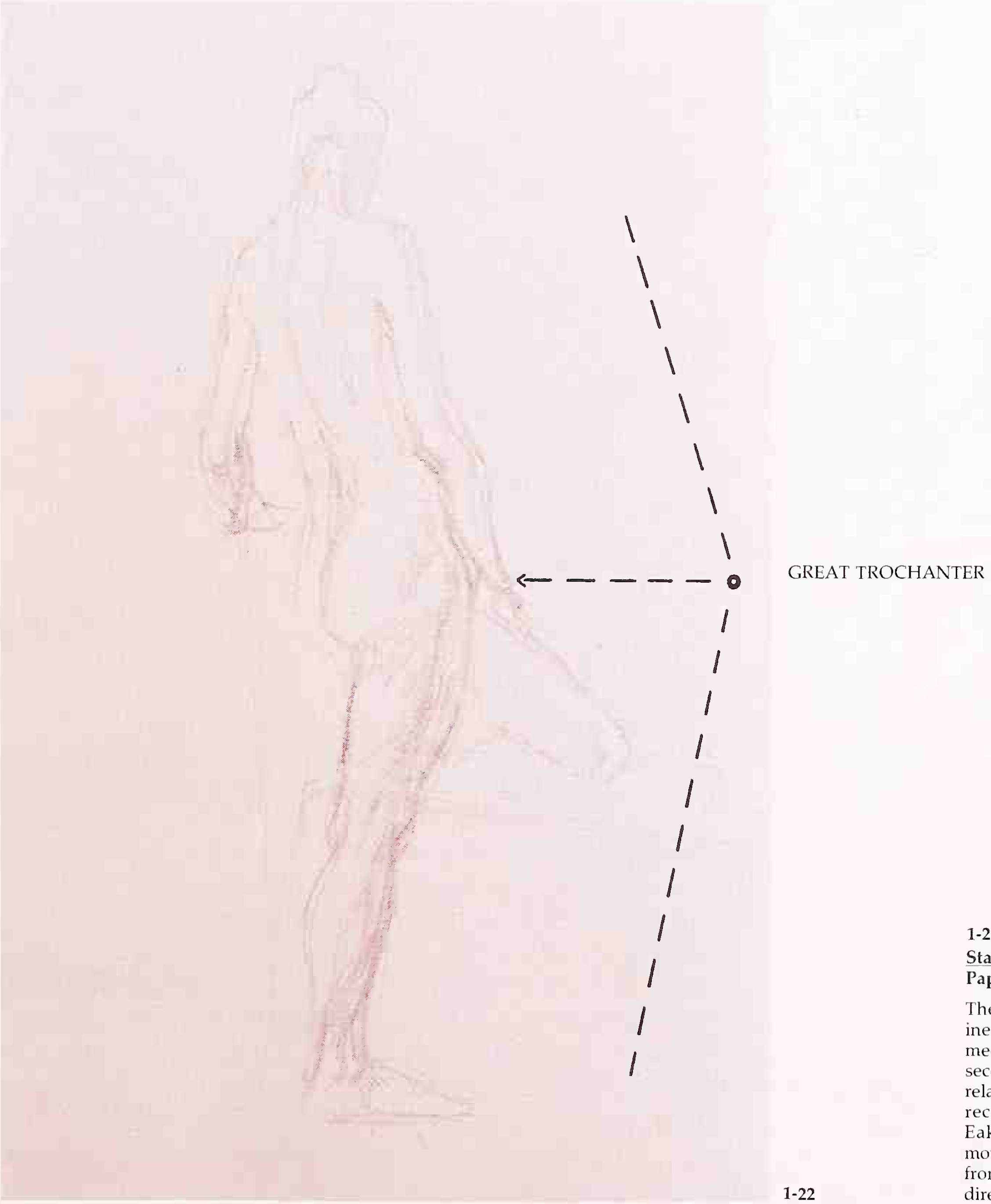
Flying Skeletons (crayon and white chalk, 1816–1906) by Daniel Huntington. (In The Brooklyn Museum Collection; Gift of the Roebling Society.)

Studies of the skeleton in perspective. To gain a better understanding of the figure in space, the skeleton should be drawn in many foreshortened positions. This will also provide greater insight into the structure of the pelvis and rib cage.

GESTURE

Enthusiasm for gesture drawing is understandable. Quick action poses combine the excitement of a visual challenge with an almost instantaneous result.

For the student of artistic anatomy, short gesture poses may be used to advantage to illustrate the mobility and altered shape of muscles. While many muscles move when an action is taken, basically, muscles act in pairs. The exercise of one muscle is offset by the action of another. For example, when the biceps is contracted, the upper arm and forearm are brought together (flexed). The triceps is relaxed. When the triceps is tightened, it extends the forearm and the biceps is relaxed. Very slow, tense gestural movement of the model will disclose a great deal of information on skeletal and muscular interaction.

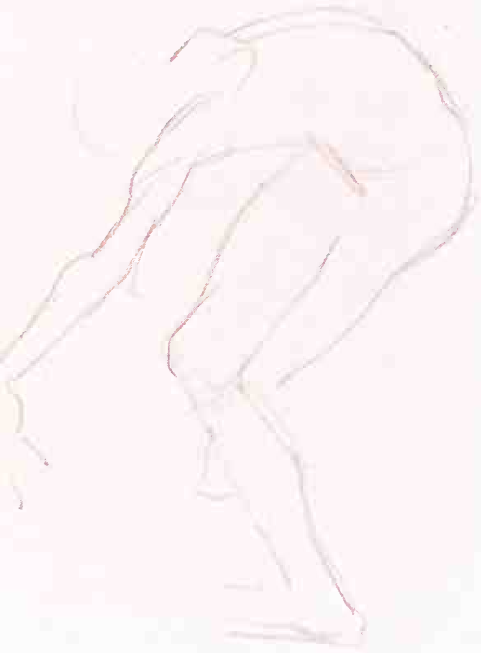


1-22

1-22

Standing Figure by Iso Papo. (Photograph by Iso Papo.

The great trochanter at the hip is the bony prominence where the two major opposing diagonals meet, the first from the shoulder to the hip, the second from the foot to the hip. All other small relationships subscribe to these two principal directions. This inner axis may be compared to Eakins's (see illustration 5-2) analysis of inner movement. These inner axes are deduced not only from internal clues but by comparisons of related directions of both enclosing contours.



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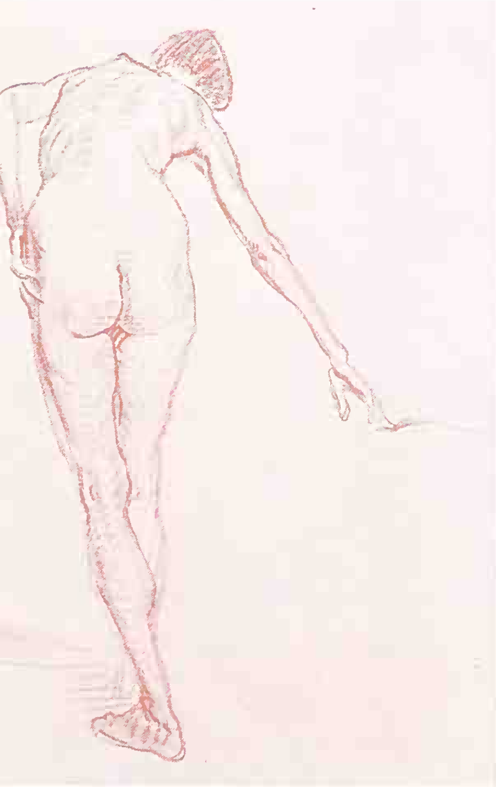

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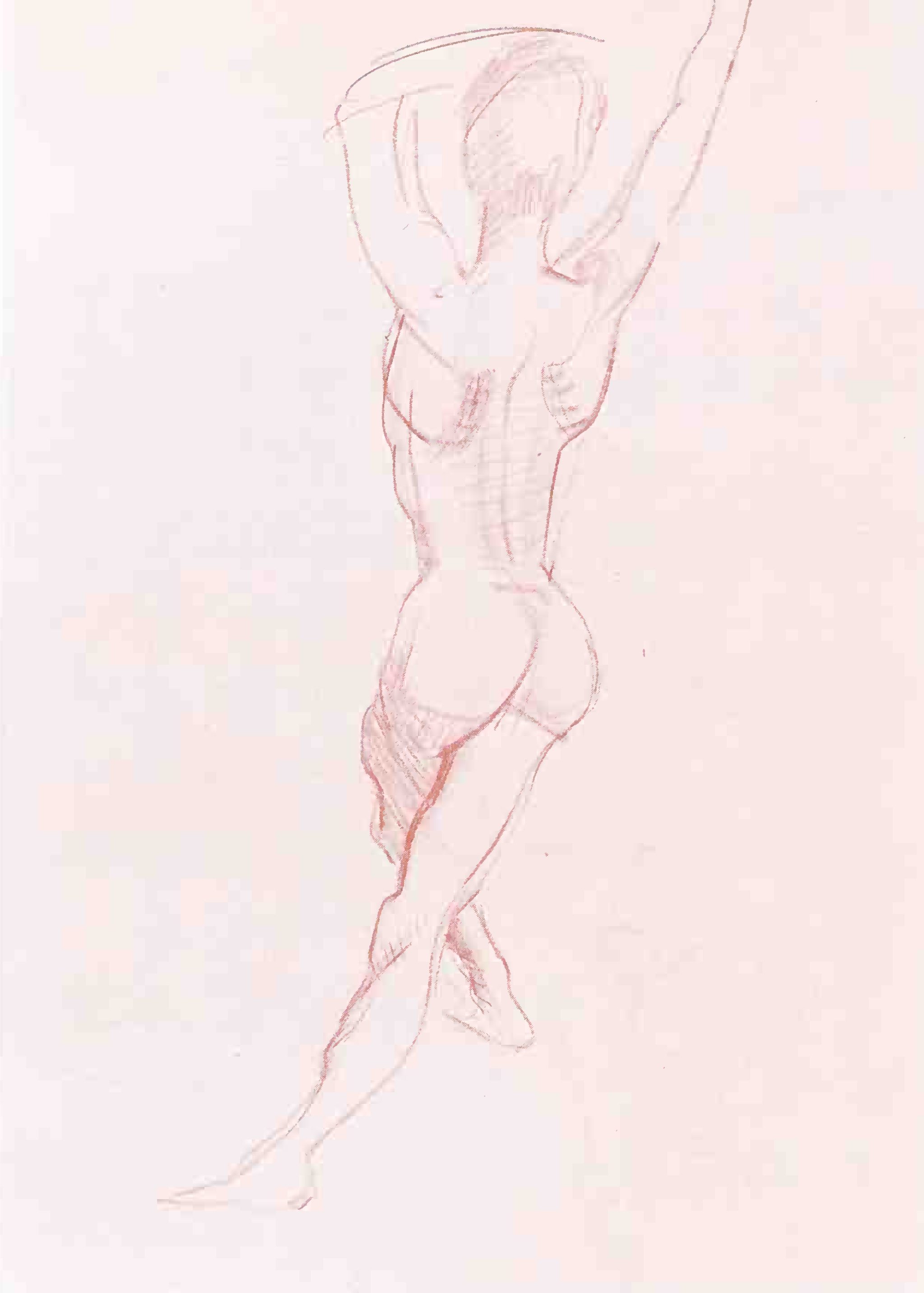


1-23

The function, shape, and direction of specific pairs of muscles may best be demonstrated on a lean, athletic model. Close scrutiny of a sequence of repeated exercises by the model should precede actual drawing. Drawing then will be supported by informed observation.

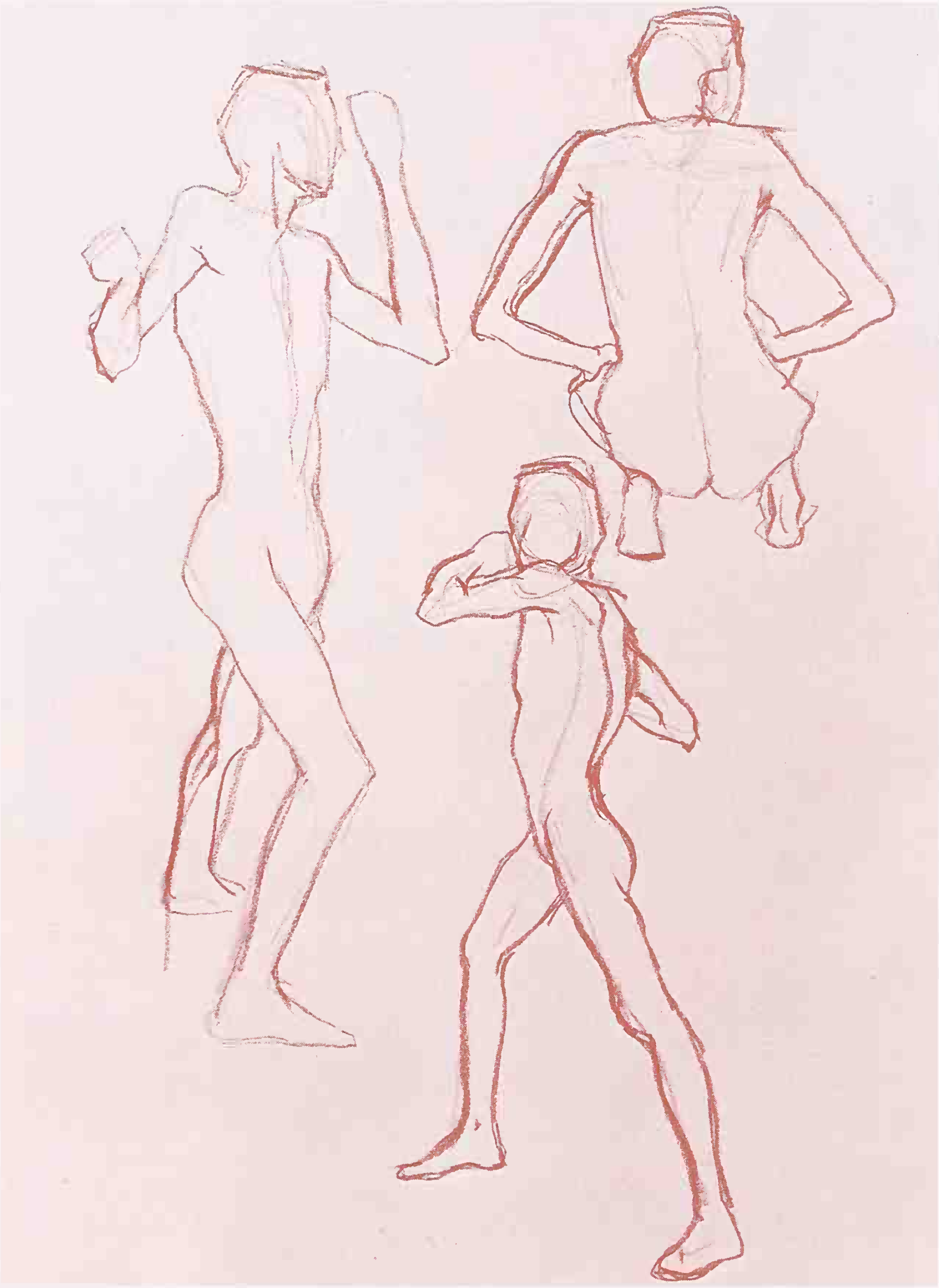
Gesture poses offer a wider variety of unusual attitudes, too difficult for the model to consider as long sustained poses. In spite of the attractions, the gesture study has its limitations. It is not a substitute for the sustained examination of the figure in a long two- or three-hour pose. The long pose is necessary to explore organic form and to grasp explicit relationships more completely. Drawing, when restricted to gesture studies, offers no possibility of a profound understanding of the figure and remains a superficial exercise.

The limitation of the long pose is lack of variety. Few models are capable of holding a transitional action that lacks balance and support. Even a comfortable, relaxed pose requires effort after a short time.

Clearly, the long pose and gesture study complement one another. Both offer significant insights into learning anatomy and figure drawing.

There is an important psychological lesson to be learned from gesture drawing. The short action pose is exciting. It stimulates an alert state of mind and demands sharp, focused attention. The draftsman should take note of this inner mental attitude. It is important for all drawing. A state of heightened visual-intellectual awareness is essential for gesture drawing and is even more crucial for the long sustained study of the figure.

It is all too easy, in a three-hour drawing session, to slip into inattentive mechanical rendering or daydreaming. Both, unfortunately, are an assurance of failure in observation. It is essential to monitor one's own mental state continually to assure sustained intellectual attention. The mental monitor is like a second self, looking over one's own shoulder to guard against irrelevant mental digressions.



1-26

1-23

Figure Reaching Up by the author. (Photograph by Iso Papo.)

A short animated gesture study (a three-minute pose) in which movement, volume, and foreshortening have been succinctly indicated. The interplay of curved and firm angular movement has been closely observed.

1-24

Bending Over by the author. (Photograph by Iso Papo.)

A one- or two-minute pose. The alert excitement generated by vigorous movement should not be limited to gesture studies. This same sharp perception should be a constant aspiration in all drawing. In the sustained much longer study it is all too easy to gradually lose both curiosity and focus.

1-25

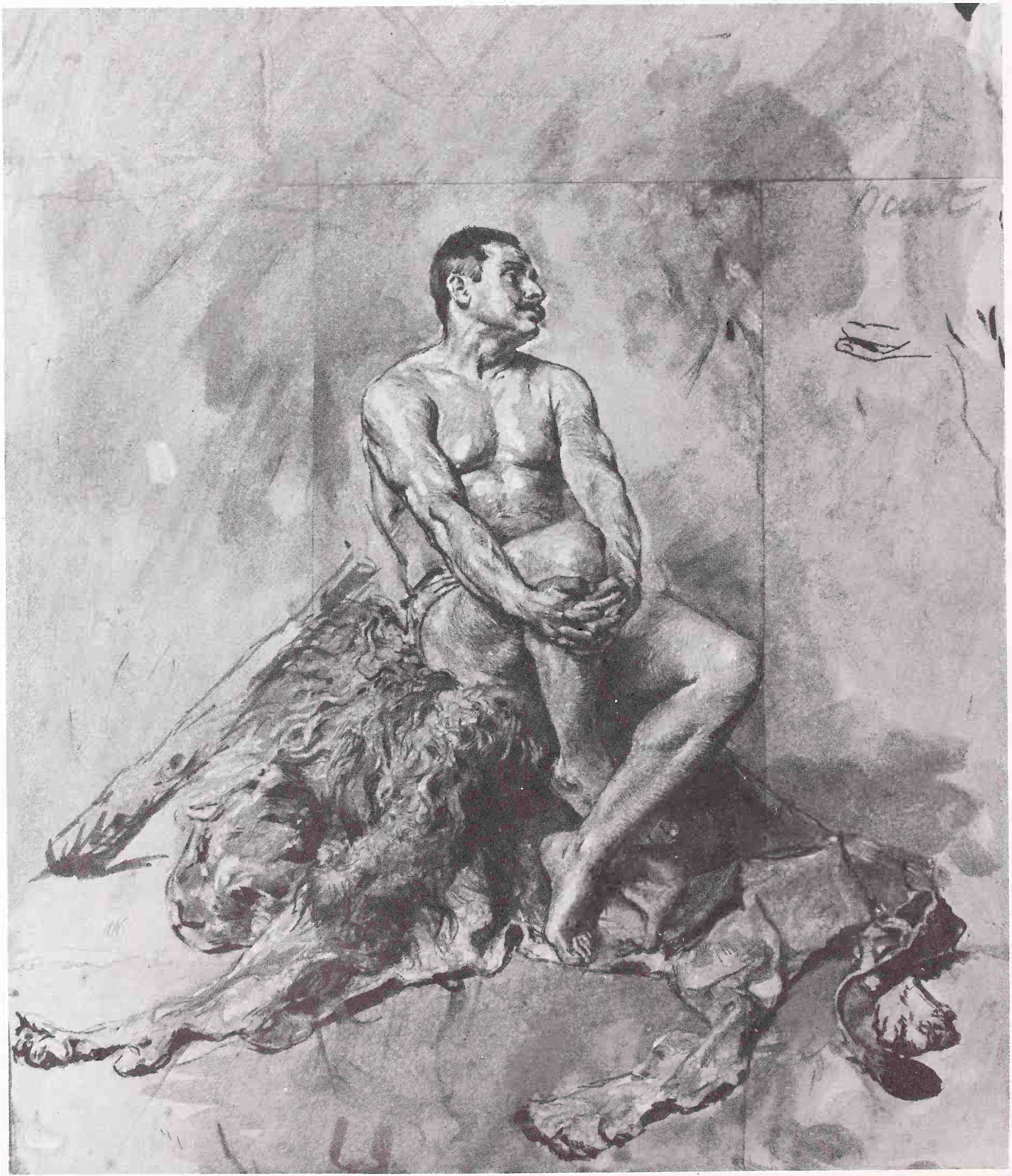
Back View Bending by the author. (Photograph by Ronald Lubin.)

A sustained gesture study contrasting stability in the legs and mobility in the upper torso and arm. The rare model able to tolerate a difficult gesture offers the opportunity to combine strong action and more closely examined forms.

1-26

Gesture Studies by Julie Campbell. (Photograph by Iso Papo.)

A student drawing of short gesture poses carried out in line. Complex opposing relationships combined with the foreshortened perspective in the shoulders and feet make the larger study on the left most effective.



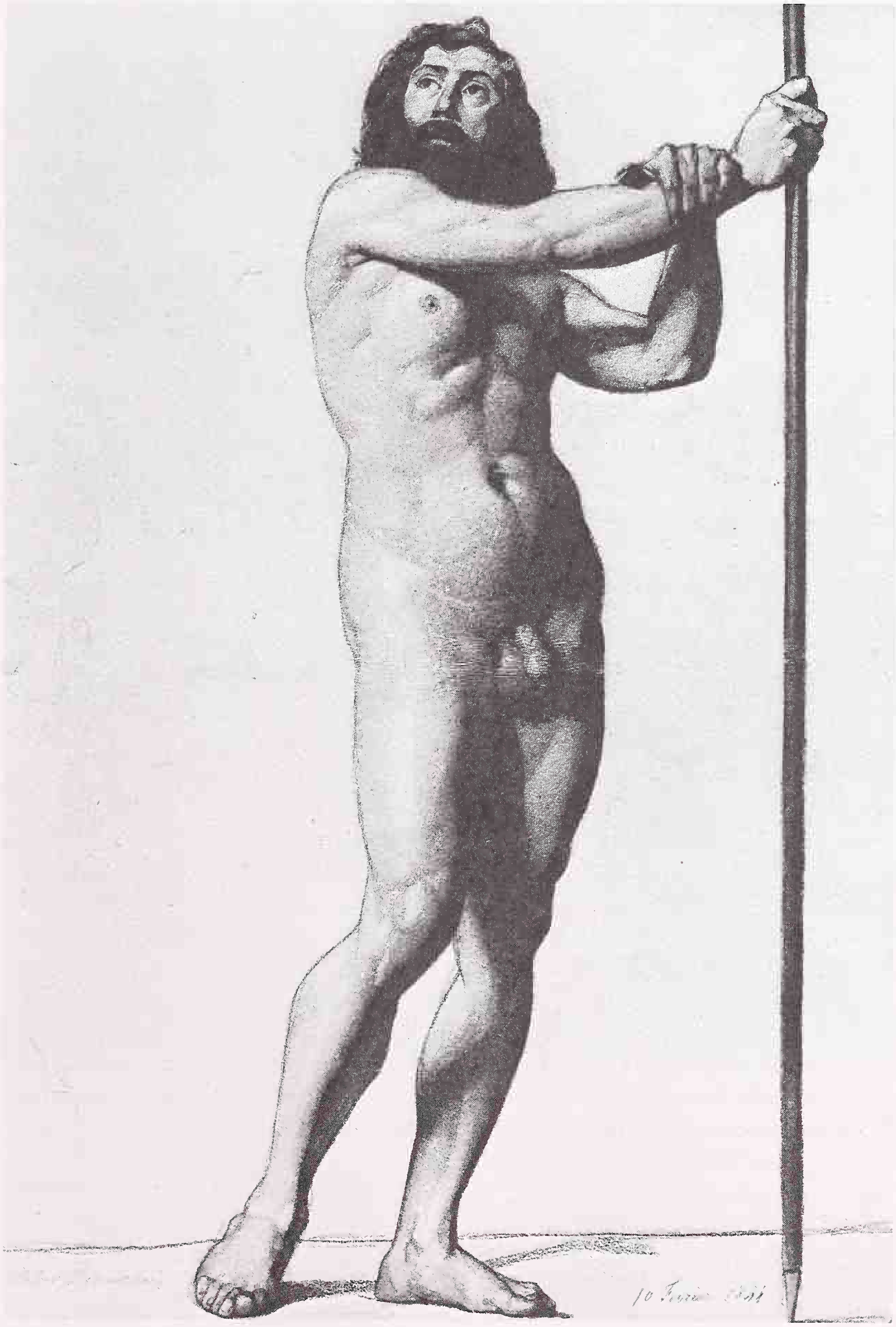
1-27

1-27

Hercules on the Skin of the Nemean Lion (mixed media) by Ernest Meissonier. (Sterling and Francine Clark Art Institute, Williamstown, Massachusetts.)

This study, carried out on joined pieces of paper, suggests that Meissonier was an unusually frugal draftsman. The artist worked directly from a posed model. Hercules is seen as an elegantly mustachioed nineteenth-century Frenchman. In spite of some fussy modeling in the legs, Meissonier demonstrates a stong grasp of volume relationships in the figure. Close attention to the location of highlights help determine plane changes in the form. The artist has successfully related the veins to the volume of the arms.

1-28



1-28

Academic Figure Study: Male Nude Holding Staff, (charcoal and estampe, 1844) by Alfred Stevens. (Sterling and Francine Clark Art Institute. Williamstown, Massachusetts.)

A powerful "Academe" by the Belgian artist Alfred Stevens. Drawings like this probably took twenty or more contact hours. For all its deliberate and careful study, the contour combines discipline with surprising freshness of execution. The staff provides a useful vertical guide to compare and establish the diagonal of the weight-bearing leg. There is a clear distinction between the dark "attached" shadows and the close family of lighter values that inhabit the lighter planes. Value continuity exists within the light side of the figure. The inscription indicates that Stevens carried out this study in the atelier Roqueplan at the age of twenty-one.

LIGHT AND STRUCTURE

Although structure has its own clear primary abstract identity, it requires the indispensable condition of light to be visually revealed and drawn. But, as indicated earlier, whereas light can reveal, it can also confuse. Misunderstood as a tracery of meandering tonal pattern, light and shade can camouflage and destroy all semblance of spatial order in forms. It must be understood selectively and apart from the relationship of the connected surfaces of a form.

While the artist, as observer, is dependent on light and shade, these are not inherent qualities of form. If a form could be evenly lit from all sides by many sources of equally intense light, the form would then reveal its allover tonal value minus shadow (value) changes. Shadow then would be canceled out as a distorting factor and as a component influencing visual sensation.

Light and shade are, undeniably, a part of an immediately sensed phenomenon, but they are variable effects, not permanences of the form. For instance, shadows change when the source of light is altered in relation to a stationary form. The fact that illumination is from outside the form may be understood intellectually but quickly forgotten in the hurried, involved activity of drawing. Then, cut-out shapes of light and dark or vague, meaningless smudges become a substitute for the underlying surface of the volume.

In the act of drawing, many inexperienced artists are too readily attracted to patterns of light and shade on the figure before they have understood the underlying structure of surface. Even after the full intellectual awareness that the effect of light and shade is a secondary consideration to surface, the habit of "copying light" is not easily overcome and results in weak and chaotic drawing. Numerous small lights and shadows on an intricate bony, muscular form seem to have no apparent order. Many unwary draftsmen treat highlights as solid shape and shadow as substance, but both are equally transient effects and should be clearly understood as such. When this is fully realized (and it cannot be stressed enough), highlight and shadow can be viewed as useful and functional in drawing, for both offer essential clues to surface development within a form.

Light and shade, or, more precisely, highlights and lengths of shadow, can act as "pointer-indicators" to space structure. Seen in relation to contour, they often bear a parallel or nearly parallel relationship and can direct the eye to surface changes at significant limits. The ability to observe and identify these alignments when they occur is exceedingly useful in drawing. (See illustrations 1-34 and 1-35.)

Surface limits, the edges of planes within a form, frequently duplicate the direction of one of the enclosing contours. Identifying and tracing parallels can direct the eye quickly to important structural relationships at each end of a form unit. The clues are revealed by the direction of lights and shadows. Contour limits and long highlights are often parallels, enclosing planes. This is not always recognized, particularly in such a varied and confused mass as the hair or through the complicated length of the torso. The parallel between a length of shadow and a contour is often obvious and more easily identified.

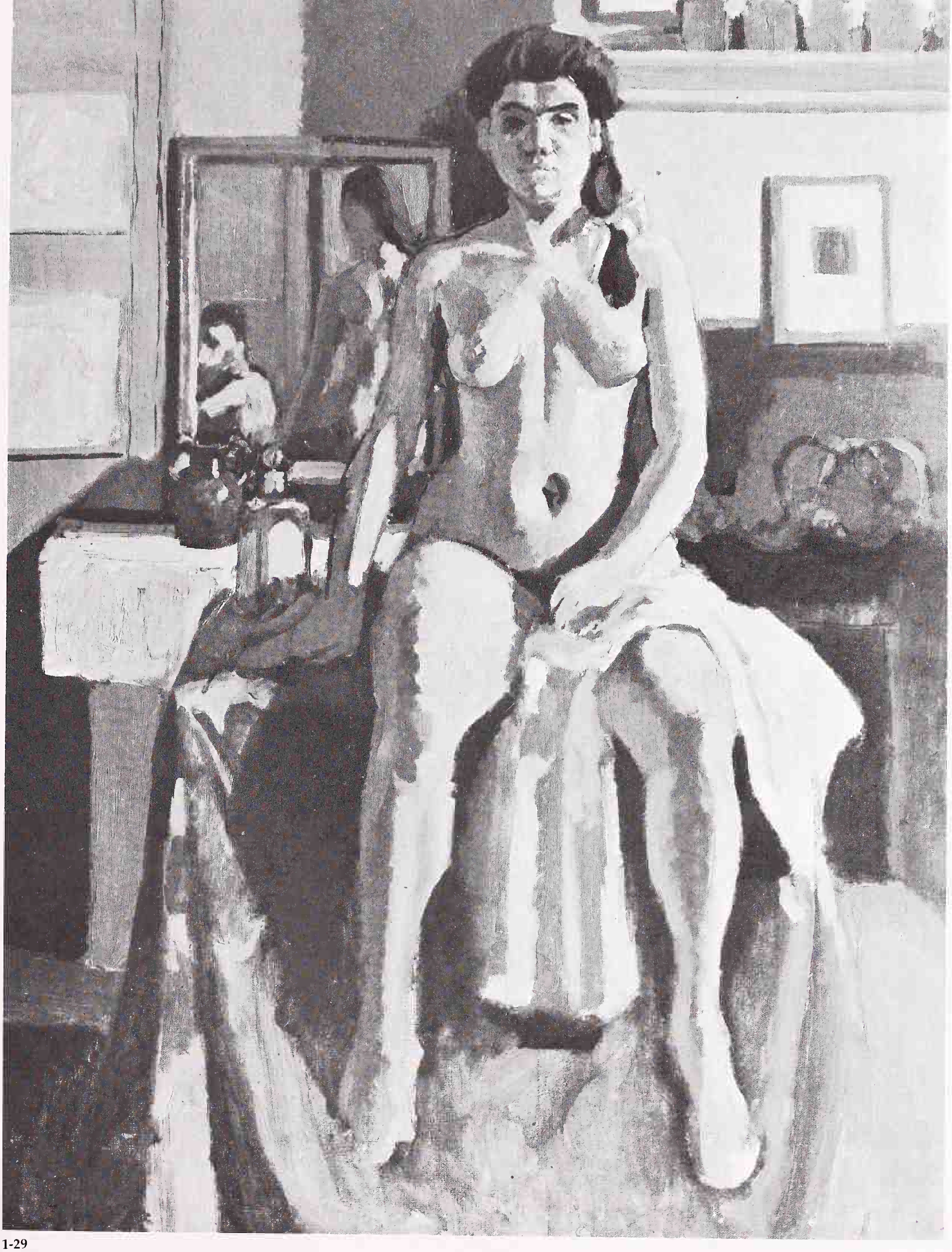
Parallel relationships in a form occur with frequency: (1) between a contour and a shadow; (2) between a shadow and a highlight; (3) between a highlight and a contour; (4) between related contours; (5) parallels across the form. It will be useful to illustrate each of these conditions.

Contour and Shadow. In *Carmelina* [1-29], a strongly lit early painting by Matisse, the precision of parallel relationships between a contour and a shadow are clearly set out in

1-29

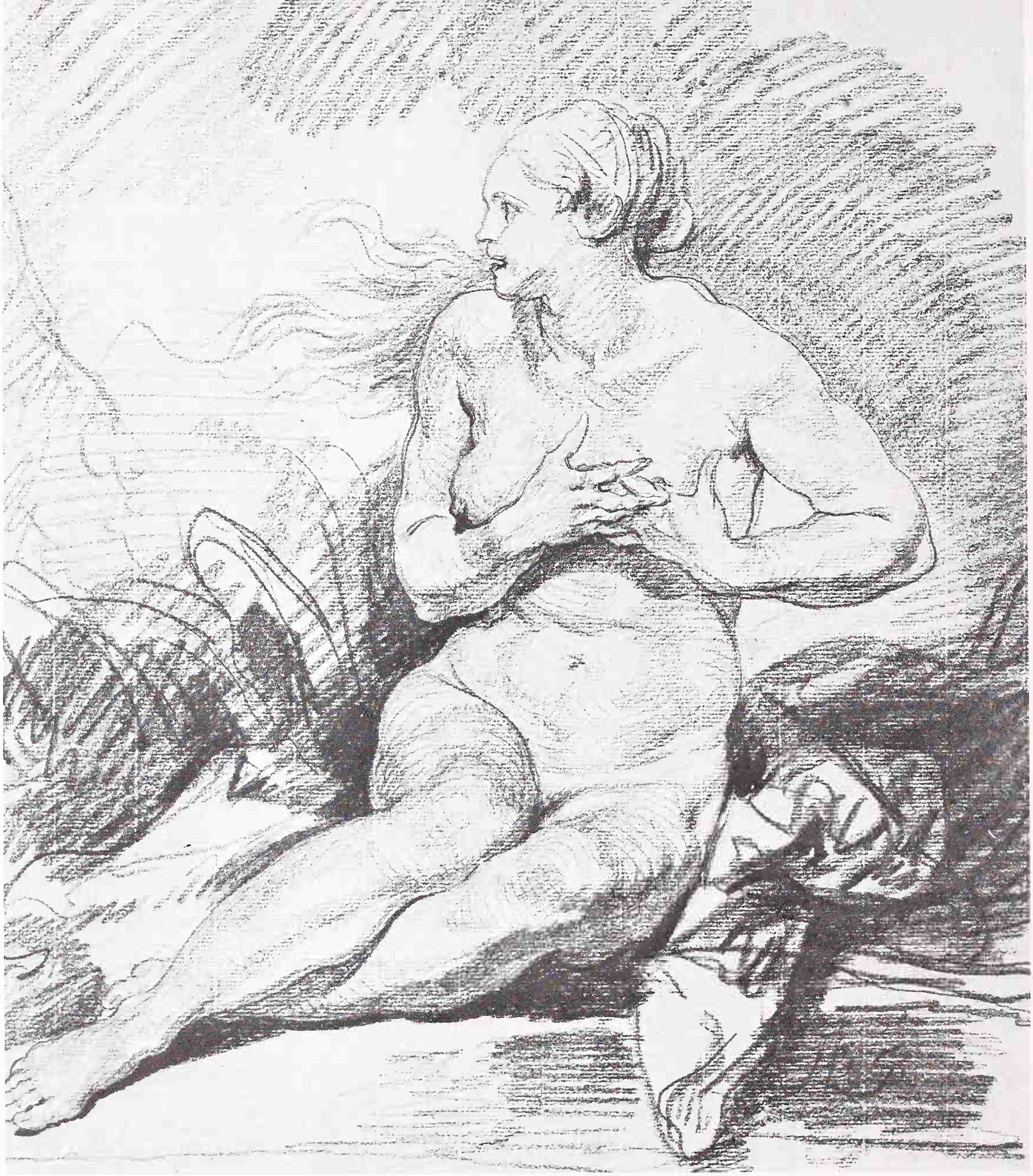
Carmelina (oil) by Henri Matisse. (Courtesy: Museum of Fine Arts, Boston; Arthur Gordon Tomkins Residuary Fund, Tomkins Collection.)

The parallel relationships between a contour and an edge of shadow within the length of a form is clearly defined in the legs. In the right leg, the shadow from knee to ankle repeats both contours of the calf. At the knee, the rectangular plane of shadow and its adjacent plane of light enclose the end of the foreshortened thigh. In this way, light and dark planes create a convincing volume from one contour to the other, supported by vigorous, accurate brushwork.



1-29

the legs. The limits of the plane of dark shadow in the right leg repeat both enclosing outer contours from knee to ankle. This surface becomes the transitional connecting plane across the form. The outer edge of this shadow follows the crest of the tibia (shinbone), the sharp, angled connection between the two front planes of the lower leg.

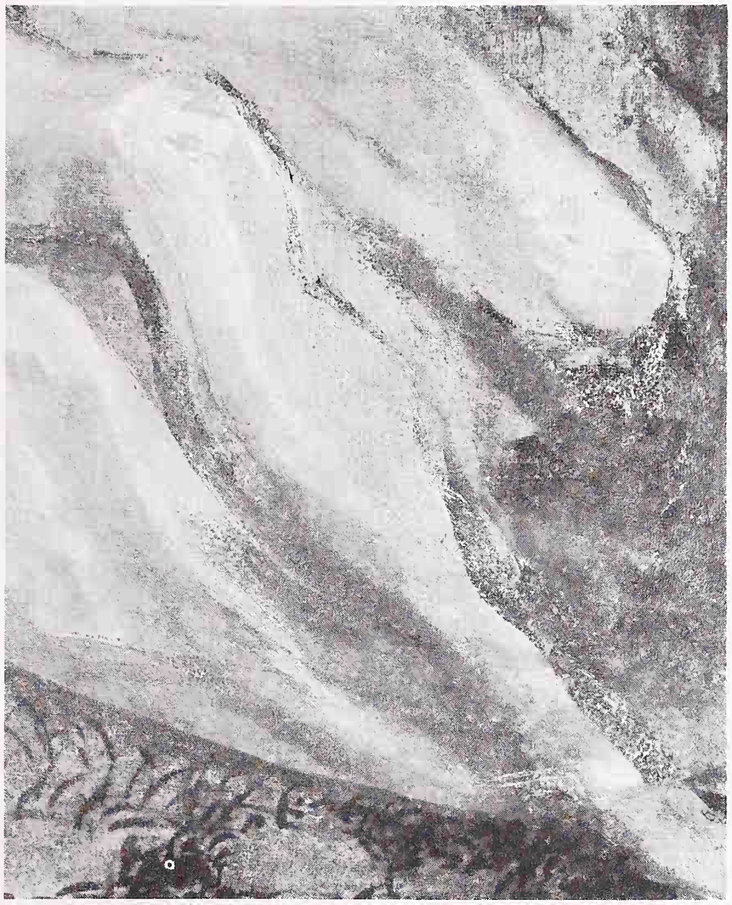


1-30

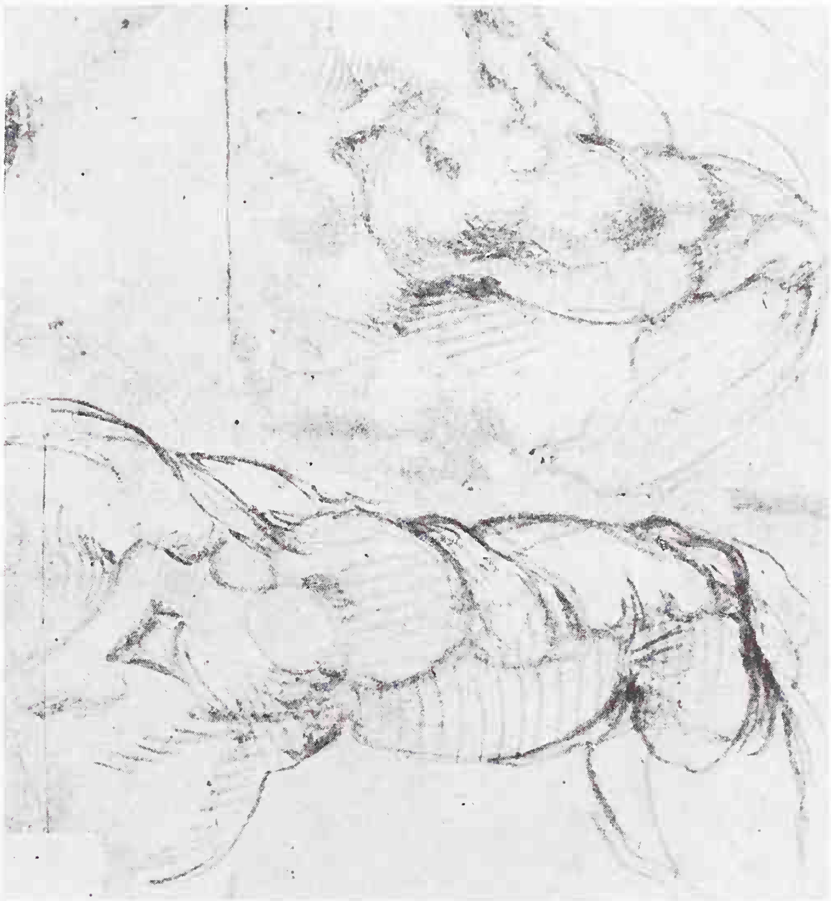
Shadow and Highlight. Parallel relationships between a shadow and a highlight occur habitually on the front plane of the nose and identify the three planes (two sides and front) that make up the larger part of this form. This close relationship between a highlight and a shadow may also be observed in the drawing by Greuze [1-30]. The highlight in the right forearm from elbow to wrist and the shadow below it from elbow to wrist enclose a long horizontal plane (directed upward from the lower contour). The receding planes above and below are coordinated in tone and contour with this inner relationship. The inner surface edge dividing the upper arm and forearm is also coordinated and ends at the highlights. The shadow below relates also to the lower contour and perspectively carries the plane away from the spectator.

1-30
Seated Nude Woman by Jean Baptise Greuze. (Fogg Art Museum, Harvard University; Bequest of Meta and Paul J. Sachs.)

The foreshortened volumes of the thighs from knee to hip contain strong modeling across the surface of each plane, emphasizing surface direction.



1-31



1-32

Highlight and Contour. Parallel relationships between a highlight and a contour are seen in the detail [1-31] from Tintoretto's technically revealing work *Allegory of Fidelity* [see 1-8]. This is an unfinished canvas showing clearly the first stages of drawing in large areas (the underpainting). The fluid but precise brush drawing in the underpainting of the leg explains clearly the two major long planes. Closer analysis is valuable. Within the large unit of the knee, the highlight follows the inner contour in a sequence some degrees lower but still parallel with it. The lower position of the highlight implies a series of diagonals that gives a forward thrust to the inner plane of the knee. It should also be noted that this highlight follows the surface prominence of the patella, the ligamentum patellae, and the long crest of the tibia (shinbone) from knee to ankle.

Related Contours. Parallels between contours enclosing a form are most difficult to identify in the larger and more complex forms in the figure. The torso in certain views and positions presents a distinct problem. Parallel or near-parallel relationships may exist between two enclosing contours in their longest overall direction and dimension (the full length of the torso). Taken singly, however, an individual contour may be widely different in each of its particular, smaller characteristics. This is the case in views of the torso and the profile of the head and neck. This may be seen clearly in the contours of the back in the drawing by Degas [see 1-18].

Parallels Across the Form. Parallels are important in related units of overlapping forms usually indicated by contour lines, breaking into a form at right angles to its length and running crosswise to the length of the form. A clear example is the arm study [1-32] by Michelangelo. The contour overlapping the back of the deltoid is part of a parallel sequence ending at the elbow.

1-31
Detail from Allegory of Fidelity by Tintoretto. (Fogg Art Museum, Harvard University; Gift of Mrs. Samuel Sachs in memory of Mr. Samuel Sachs.)

The relationship between a length of highlight and a parallel contour from the knee to the ankle is a first, precise observation in this unfinished work by Tintoretto. It is a revealing study of essentials in developing a form. (The entire painting is reproduced in illustration 1-8.)

1-32
Detail from Study of an Arm by Michelangelo. (Teylers Stitchting, Haarlem.)

Linear parallels extending across the back (top) plane of the arm from the shoulder to the elbow. The curve of the deltoid, the diagonal triceps, and the direction of the condyles of the humerus establish a related parallel sequence cutting in from the long contour and support the perspective of this plane.

CAST SHADOWS, HIGHLIGHTS, AND MODELING

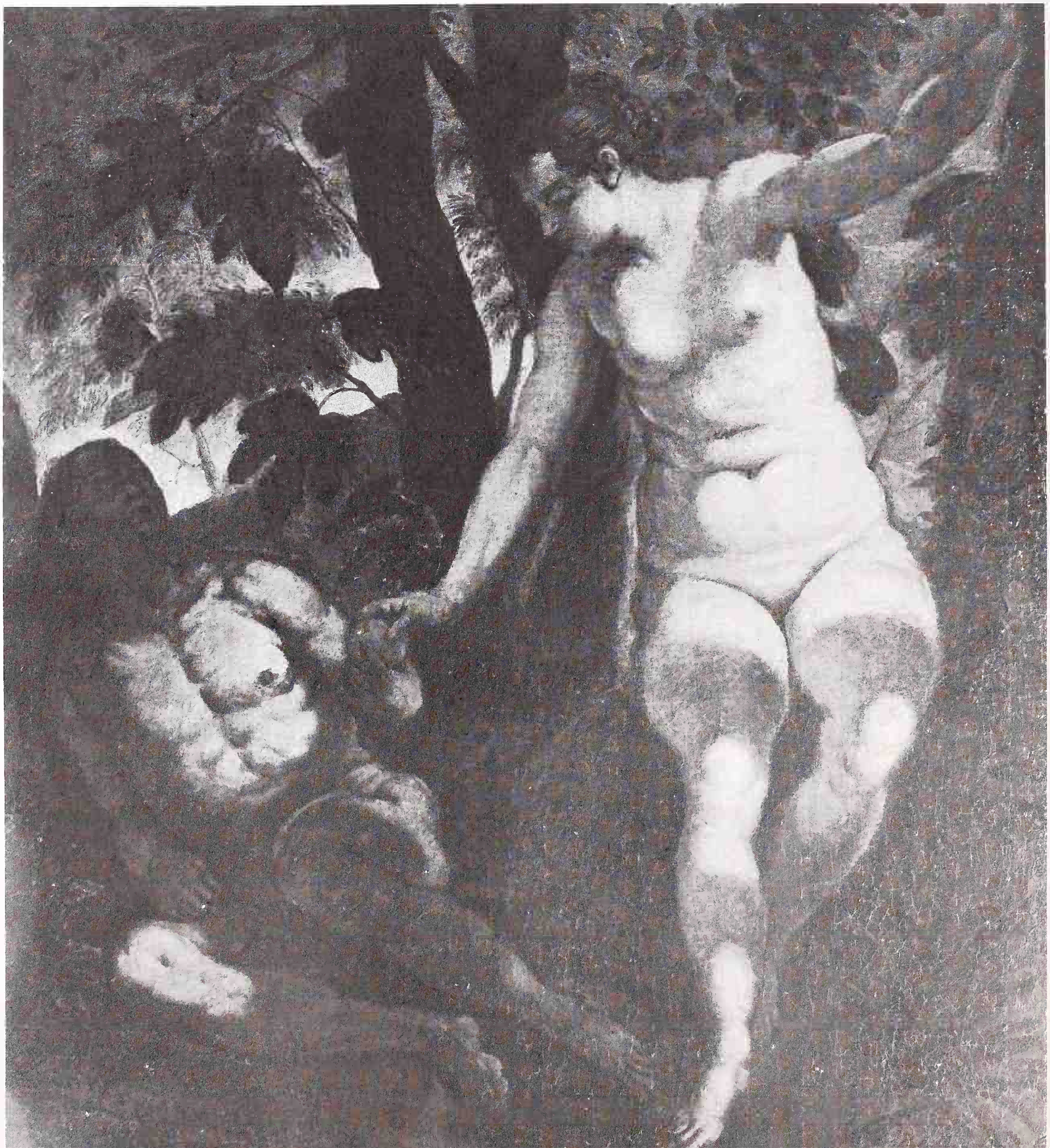
1-33
Adam and Eve (oil on canvas) by Tintoretto. (The National Gallery of Canada, Ottawa.)

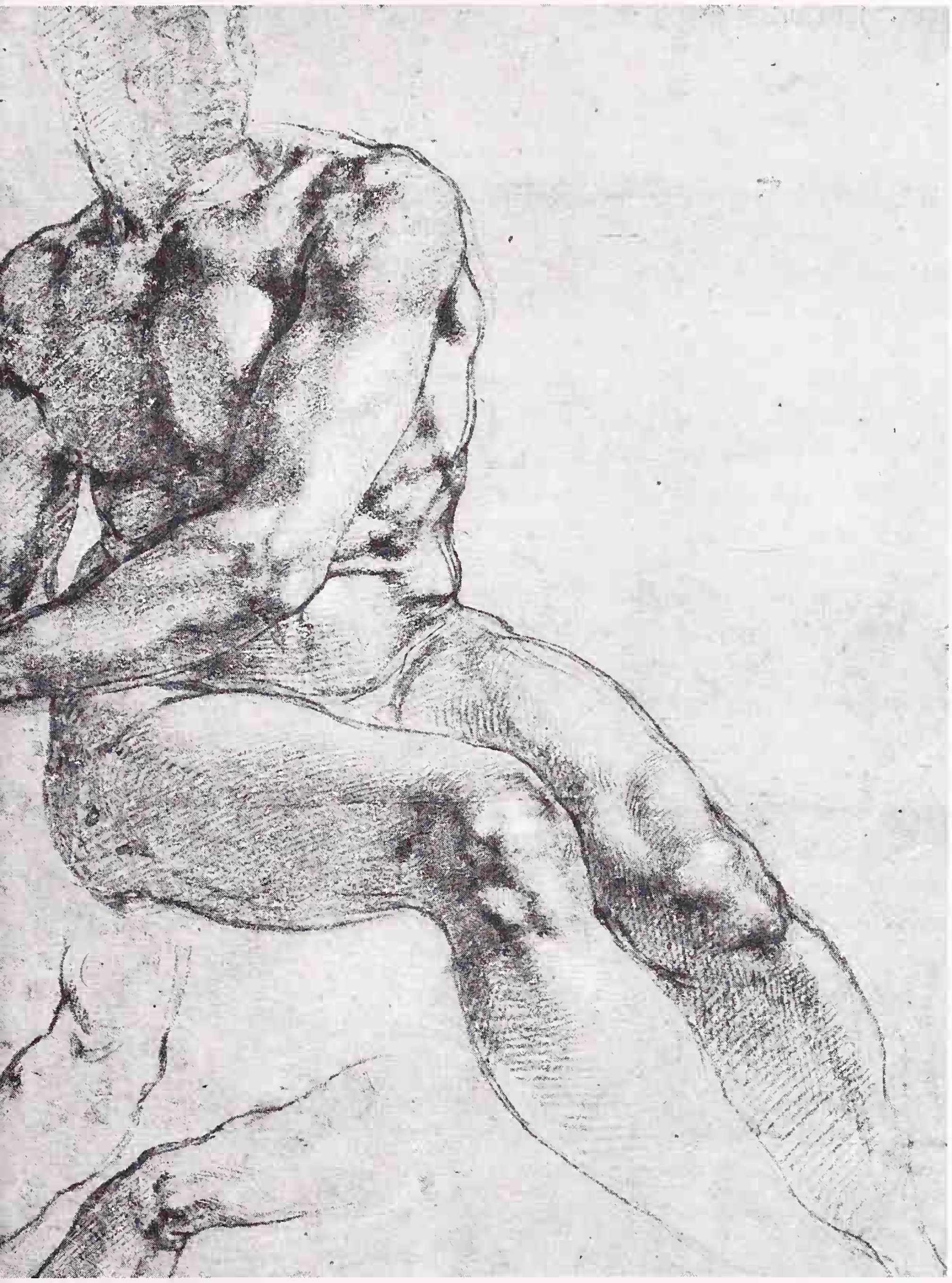
Cast shadows, encircling the legs, emphasize their conical volumes. Perpendicular directions running through the length of the thighs may be picked up within the encircling shadows. The inner edge of reflected light is tied to surface changes ending at the knee and hip in the right leg. (Study the shadow side of the torso for parallel directions from hip to breast.)

Cast shadows present a perplexing problem to the draftsman. Clearly the product of an influence from outside the form, they are nonetheless a part of the visual phenomena with which he may have to contend. A ribbon of shadow cutting across the middle of a form can be revealing if intelligently understood or result in disaster if not.

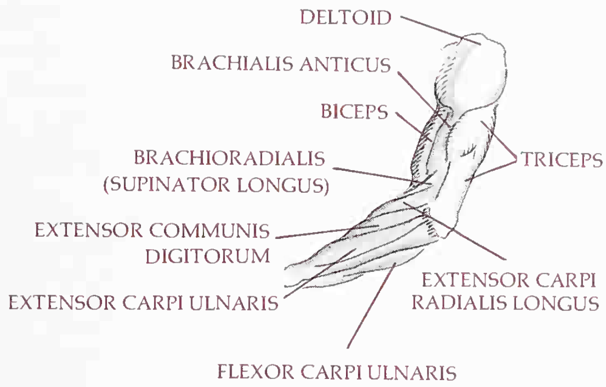
In the Tintoretto *Adam and Eve* [1-33], the figure of Eve presents a typical baroque compositional device—the dramatic use of the cast shadow. Both thighs are encircled by broad bands of shadow (cast from a nearby tree) and create a dramatic pattern. They

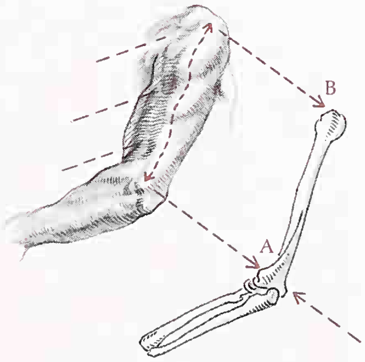
1-33





1-34


DELTOID
BRACHIALIS ANTICUS
BICEPS
BRACHIORADIALIS (SUPINATOR LONGUS)
TRICEPS
EXTENSOR COMMUNIS DIGITORUM
EXTENSOR CARPI ULNARIS
EXTENSOR CARPI RADIALIS LONGUS
FLEXOR CARPI ULNARIS



1-35

give immediate emphasis to the modified conical volume of the form. At first glance these shadows have the appearance of easy fluid curves. On closer examination, a more precise change from the vertical to the horizontal curve can be identified. A glance at the perpendicular movements from knee to hip will reveal connections of an important kind. Vertical and horizontal curves at the hip are repeated at the upper shadow edge and precisely where the vertical plane of reflected light on the inner thigh meets the darker horizontal shadow plane on top of this form.

A knowledge of bone structure, particularly as it affects an articulation (i.e., wrist, elbow, knee, etc.) or the extremity of a form, can offer a means of identifying related directions of shadows indicating major broad surface connections within a form. Sharp points of highlight are also helpful as clues to a coming together of related planes. Again caution is in order not to abuse the planes in favor of the clues.

In seeking structural limits within a form, the direction of thin linear highlights is as useful as directions through shadows. Connected directions of interrupted linear lights on undulating surfaces are, however, more difficult to recognize. A pattern of sharp highlights can form a direction. Their identity, through their length to the end of a form, can often pinpoint a major structural surface change [1-34, 1-35].

1-34
***Study of a Nude Male Figure, Seated* (red chalk) by Michelangelo. (Graphische Sammlung Albertina, Vienna.)**

A number of apparently independent small highlights discovered on curved and undulating surfaces may form a connected sequence pointing to a structural limit at each end of a form. In this study, the highlighs are directed to the greater tuberosity (shoulder) and the external epicondyle of the humerus bone, indicating the relationship between the planes of the back and side of the upper arm.

1-35
Analysis of an Arm.

This analysis is based on the study by Michelangelo [1-34]. The sequence of highlights points to each end of the humerus, the external epicondyle *(A)* at the elbow and the greater tuberosity *(B)* at the shoulder. This alignment is the connection for broad planes on the back and side of the arm. The muscles, as smaller form units, fit into this broader scheme.

Location is the key and guide to the modeling of a form in light and dark. Carefully organized relationships at each end of a form, once established, cannot be ignored. A haphazard scratching in of a tone can violate space and volume structure and distort surface relationships within a volume.

There are a variety of approaches to modeling. One is the classic method in which modeling lines are curved into the form at right angles to its length. Another is modeling by means of lines running parallel to the length of a form (that is, parallel with the contour). To preserve spatial order, modeling should be consistent with all other factors in the drawing.

The completeness of a mental, abstracted structural image may vary from drawing to drawing, depending on the scope of the individual work. Technically, a wide range of modeling (or no modeling) is opened up. Many of Degas's pastels, for instance, contain all vertical (or slightly diagonal) modeling but remain three-dimensionally convincing due to an underlying structural order.

With skill born of much drawing experience, structure can become part of a fundamental identity kept in mind rather than directly expressed. This structural image held in mind just above the drawing paper then permits an enormous range and uniqueness of expression without loss of order.

The complexity of the human form may require a part of the anatomy to be understood within a hierarchical structure of two levels. This is the case, first, where a small form unit has its own internal structural identity. Also, the same unit, by its location over a larger form, expresses the dimension of the hidden or partially concealed volume beneath. One level is large and fundamental; the other is small and complex. The first is held in mind; the second is drawn and, by its representation, reveals the first. Like H. G. Wells's invisible man, it can only be seen when clothed. For example, the structure of the shoulder blade is often visible as a complete triangular framework in the back. It has its own internal structure. But, by its angle and position over the major curving dimension of the rib cage, it functions also to limit the larger form of the torso at the upper back and shoulder, thus serving a dual function in drawing (see illustration 5-18).

The selective abstraction of significant locational relationships with a complex form, to reveal precisely the form's broad spatial order, is a disciplined activity of eye and mind. In practice, the approach to drawing is one in which the visual sense experience of reality is subjected to intellectual analysis. It is important to bear in mind that observational drawing is not simply a retinal response to visual sensation. This results in shadow "copying." The significant preliminary groundwork in drawing is the spatial information (measurement or dimensions) deduced from observation and separately identified (symbolized by line and point).

CHAPTER 2

PERSPECTIVE AND FORESHORTENING

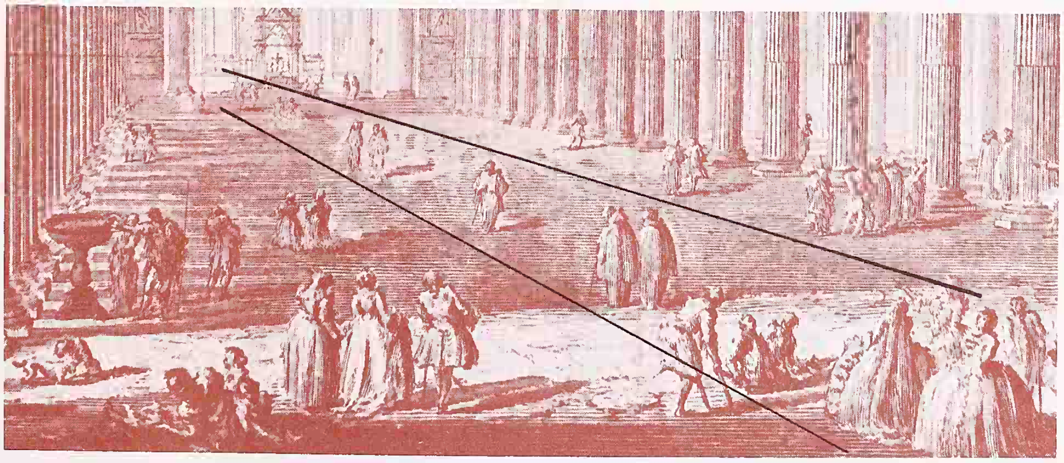
One of the abiding difficulties in observational drawing is the perplexing problem of foreshortened forms. These are invariably drawn too long. Inexperienced students frequently impose an idea of the actual "known" length on the visually reduced length of a foreshortened volume or plane in perspective. As a result, part of a drawing will appear out of scale to the general representation of forms (for example, the inadequately reduced dimension of a projecting arm in relation to the torso). Here, knowledge and perception can create a conflict of visual understanding that requires adjustment to a uniform perspective (that is, to the station point of the observer). Few individuals are fully aware of, or take the time to check, foreshortened measurements.

PERSPECTIVE, FORESHORTENING, AND THE PRINCIPLE OF CONVERGENCE IN OBSERVATIONAL DRAWING

Formal geometric perspective provides a simplified but acceptable approximation of depth perception. It offers a graphic parallel to human vision in observational drawing and creates the illusion of three dimensions on a two-dimensional surface. On a practical level, its cumbersome mechanics are primarily useful for architectural and formal geometric relationships (e.g., cube, cylinder, cone, pyramid, or involved combinations thereof).

When the human figure is represented as a form in perspective, it is measured for the most part as one of a series of separate receding images sequentially reduced in scale [2-1]. But the anatomical relationships of parts of the human body may also be drawn to conform to a consistent visual point of view.

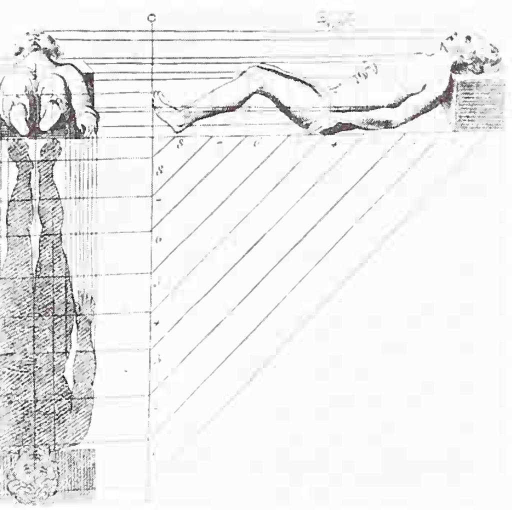
2-1



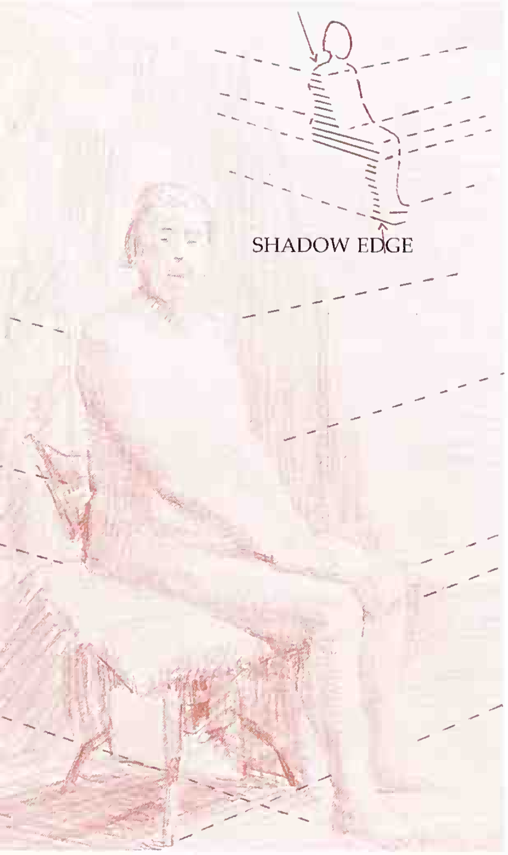
2-1

Detail of St. Paul Outside the Walls by Piranesi. (Collection of the author. Photograph by Jonathan Goell.)

Perspective of the human form is often understood to mean the scale reduction of a sequence of complete figures in a receding space.



2-2



2-3

Several attempts have been made to create viable formal perspective systems for the general anatomy of the figure. Piero della Francesca, Albrecht Dürer, and Jean Cousin each developed an elaborate scheme for the geometric projection of the body structure [2-2]. But applied to complex organic forms like the human image, the systems required an unwieldy, time-consuming perspective substructure that discouraged their general adoption by artists. For example, Piero used two projections of the front and profile views, to foreshorten the human head. Ignoring the geometry, artists have accepted the principles and applied them with acute observation to freehand drawing and foreshortening.

Foreshortening is a freehand extension of formal perspective applied to drawing forms visually compressed in depth. As a term, *foreshortening* seems to relate to the specifics of an individual form. One generally does not apply the word *foreshortening* to a landscape or an involved interior space. One foreshortens specific aligned form units, but the relationship between forms is defined by a larger spatial context. (Interstitial space refers to the space between forms by itself, not the total concept of form and space.)

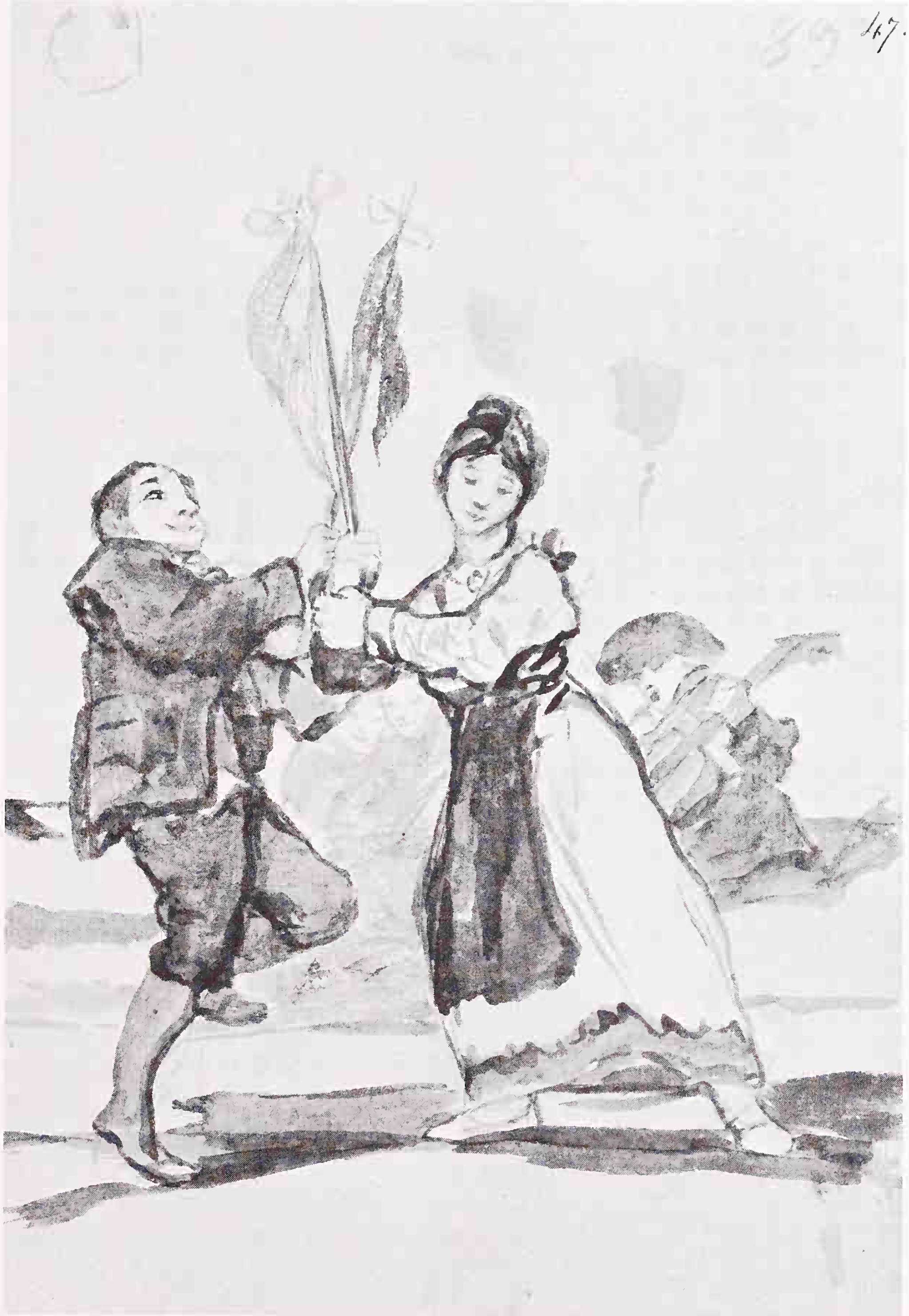
Implied within the term *foreshortening* is the diminution in scale of forms and surfaces in a receding space. The eye contains the regulating visual mechanism for this scale reduction. It is a basic characteristic of the way the eye sees. Perspective codifies the perception of size reduction in spatial depth by linear convergence (lines converging to a common vanishing point). The principle of convergence, divorced from the total apparatus of linear geometric perspective (ground plans, elevations, vanishing points, etc.) is incorporated in the perception of forms in observational drawing. In the context of depth perception, the size or scale of an object is measurable at any location and in any direction. The principle of convergence covers the many unstated perspectives in the perception of forms, including the structure of complex organic forms in the human figure.

But the combined foreshortenings that comprise the many surfaces and forms in a figure drawing are not a random montage. Whatever their direction, they subscribe to an overall order. The guiding optical control to which multiple foreshortenings relate, in a comprehensive space, is the location of the observer.

In freehand observational drawing (i.e., drawing from directly observed forms), the regulation of an ordered integrated figure perspective is given by one constant—the height of the eye from a ground plane in relation to forms within the visual field. In perspective this is called the station point.

But unlike the unvarying viewpoint of the eye in perspective, the observing eye has to move. The eye is not stationary, even from a so-called single station point. It would be more precise to say the eye socket is the constant station point. Within the socket, each change of focus of the eye alters the perspective slightly. It would not be possible to relate one object to another without this small degree of movement. Attention and eye movement coincide to identify visual fact. (An instant example of this coincidence is the multiple mind-eye focusing on this page.) The relationships established in a drawing done directly from observation combine numerous allied optical viewpoints within the controlling limit of the station point. In spite of this necessary and permissible degree of eye (and head) movement, the artist-observer should maintain a conscious and constant viewpoint in relation to the subject of the drawing.

Foreshortening defines visual compression in drawing. Convergence is foreshortening with a vanishing point. Convergence, as a concept derived from graphic perspective structure, implies an open-ended, unrestricted network of multiple vanishing points, which by implication animate a total drawing. An analysis of segments of complex units in the figure would reveal a foreshortened perspective of each part, all subscribing to a larger visual order controlled by the station point of an observer.



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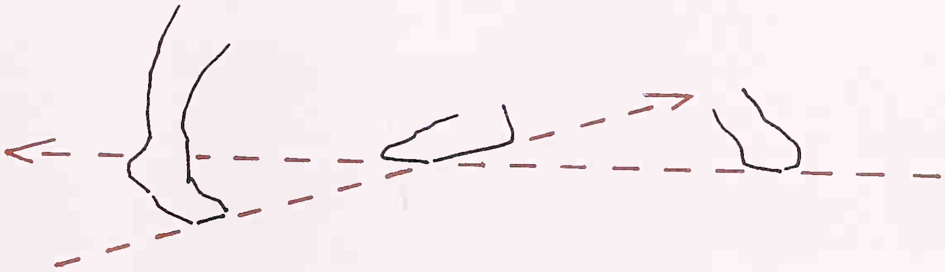


2-5

2-2

A Foreshortened Figure from L'Art du Dessin (1671) by Jean Cousin. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

This illustration is from a work that attempts to apply formal perspective projection to the problem of foreshortening in figure drawing. Top and side views are disposed at right angles. Vertical and horizontal dimensions are intersected to provide a foreshortened figure at *(A)*. The scheme is limited and cumbersome.

2-3

Seated Nude (Photograph by Barney Burstein.)

A symmetrical pose permits an easier explanation of perspective order in the figure and the perspective intersection of large light and dark planes. The major continuous edge of shadow through the upper arm, hip, and leg identifies the broadest opposition of planes in the figure form. All smaller planes integrate into this large scheme. Irregular, unsymmetrical poses with less obvious perspective alignments nonetheless need careful analysis for a clear spatial perspectival order.

2-4

Provincial Dance (brush and brown wash) by Francisco de Goya. (The Metropolitan Museum of Art; Harry Brisbane Dick Fund, 1935.)

In drawing the figure, it is important to establish its relation to a supporting plane. In this brush drawing, the feet help describe the perspective of the ground plane. The two planes in the supporting foot of the young girl form a pivot for two intersecting directions within the cast shadows beneath the dancing figures.

2-5

Ground Plane Analysis.

In the sketch by Goya [2-4], the middle foot is the point of intersection for the brush work describing the perspective of the ground plane.

Since its development in the early Renaissance, geometric perspective has had a profound influence on the language of expressive forms employed by the visual artist. It is clear that the influence extends far beyond simple three-dimensional geometric representations, but, by extension, its concepts viewed as open-ended constructs are applicable to the most intricate irregular relationships in drawing. The derived concepts of visual convergence and foreshortening are among the significant contributions of perspective to the visual language of the artist.

Perhaps *multiple convergences* would be a more accurate designation of the optical experience of visual perspective. One contemporary painter who consciously used multiple perspectives in landscape painting was Oskar Kokoschka. It should be stressed that this was not montage making, but rather connected multiple viewpoints employed to compress a wide topographical landscape into a manageable rectangular format.

Probably the best means to learn and master foreshortening is direct observation—keeping in mind the principles of perspective. (Perspective theory is thus placed in the service of observation.)

The psychology of perceptual disbelief in the sharply compressed dimensions of foreshortened forms is often very difficult to overcome. It results in repeated, unintentional, out-of-context distortions in drawing. For this reason the careful measurement of foreshortened forms is crucially important. A number of visual techniques are known and used for this purpose, all related.

THE SILHOUETTE AND THE VISUAL FIELD

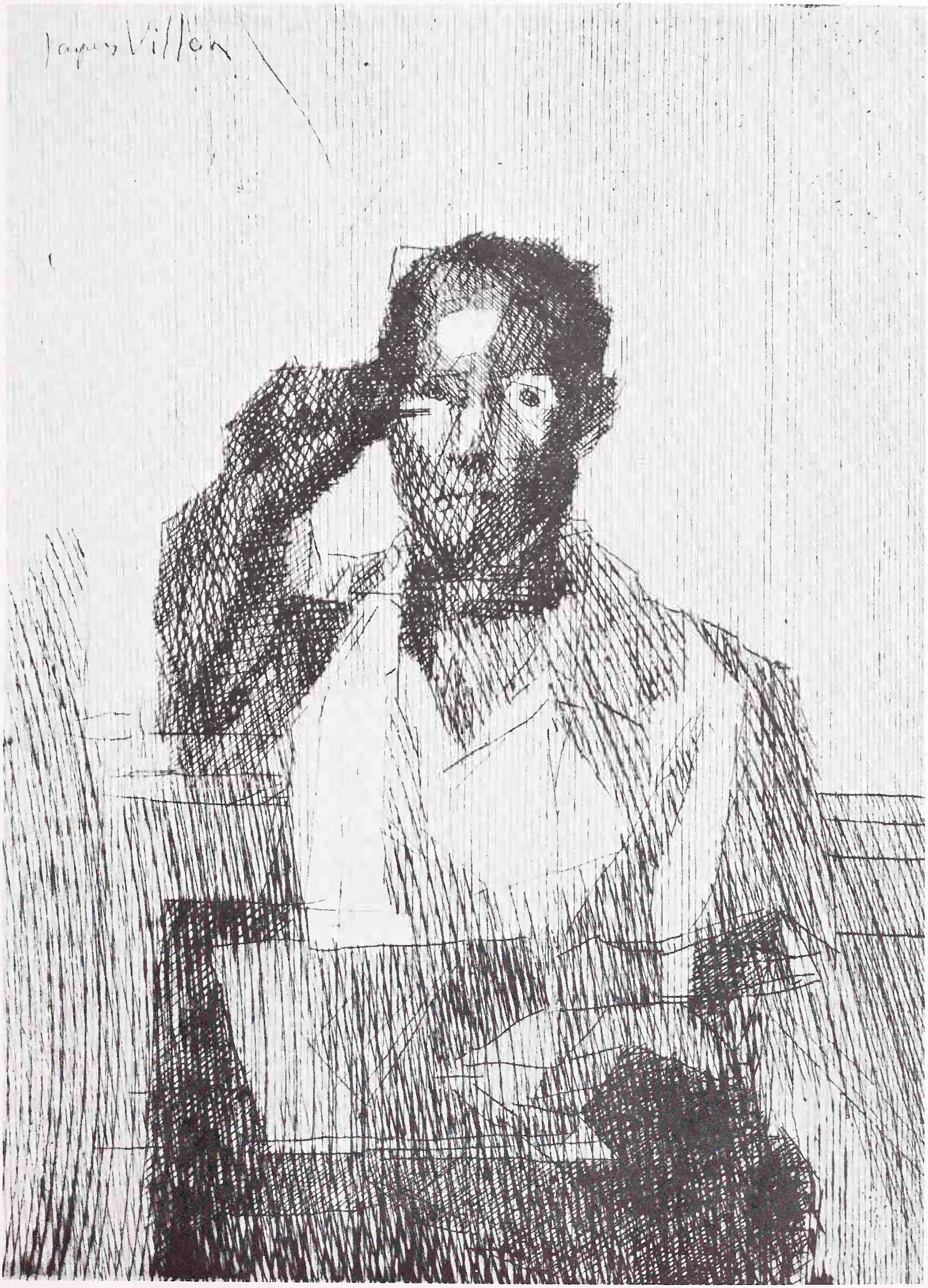
By far the most effective means, in my view, to achieve convincing foreshortening is the measurement of forms and spaces viewed two-dimensionally—that is, measurement of a form by its silhouette and its related contiguous negative spaces. This compels a visual reduction of observed, three-dimensional reality to a two-dimensional field (consisting of height and width). It may be described as a perceived flat transparent plane on which forms have been reduced to flat shadow shapes surrounded by flat spaces (like a window with reality glued two-dimensionally to its outer side). It is directly pertinent to locational structure discussed in chapter 1 and can ultimately become an integral part of unified structural vision.

To measure an observed, foreshortened form, it is necessary to abstract the spatial attributes of its silhouette (height and width). These two attributes of space, by themselves, "fix" the visual limit of the observed third dimension or depth (i.e., the foreshortened dimension). Observationally, the silhouette of an object is its two-dimensional shape configuration seen from a precise given viewpoint. This brief flattening of the visual field emphasizes not only the silhouette, but also the shape relationships between and around forms. No matter how irregular these configurations may be, they provide evidence of the missing foreshortened third dimension, usually in the shape of diagonal edges.

2-6
Le Petit Dessinateur (etching) by Jacques Villon. (Courtesy: Print Department, Boston Public Library. Photograph by Jonathan Goell.)

Thumb and pencil measurement is a guide and an aid to observation for Villon. For this artist, disciplined vision was essential to expression.

In his etching *Le Petit Dessinateur* [2-6], Jacques Villon has drawn himself in the act of making a dimensional measurement. The etching offers clear evidence of careful observation. Using the thumb and pencil system, the artist is measuring the span of a horizontal dimension. For Villon, the concept of precise, disciplined visual measurement


Jacques Villon

2-6

is more than a symbolic action employed as a subject. It is representative of an attitude and a practice reflected in all of his work. The measurement being taken is of a specific single spatial attribute, a "width." Had he held the pencil vertically, he would be measuring a "height." In both cases the measurement identifies an aspect of form or space that is two-dimensional. The artist is momentarily ignoring depth. He is, in effect, measuring across the visual field as though it were a flat plane.

As an abstraction, the measurement may be the width of a form (or part of a form), a foreshortened form, or the space between forms. Thumb and pencil measurement is a means to make accurate comparisons between lengths of form or space, height with width. The procedure can entail the comparison of a visually undistorted length with a perspectively foreshortened length, to measure the degree of foreshortening.

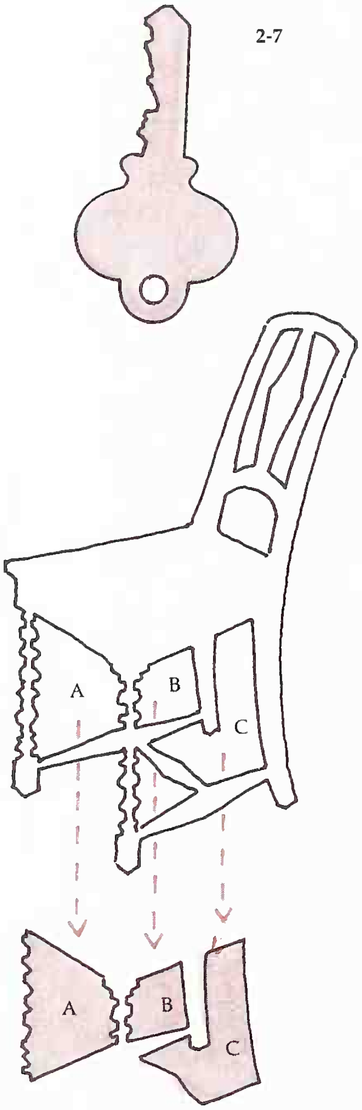
A less fragmented means to determine foreshortened relationships involves the visual reduction of a three-dimensional field to a visual plane of two dimensions—a visual configuration of silhouettes and open negative spaces. (The term *negative space* is used to describe those contiguous intervals of space between and around forms.) The shock of this visual action can be an immediate awareness of a compressed foreshortened dimension. The impact of the silhouette is important in an added sense.

The configuration of a flat shape is dependent not only on the area contained by its contour, but is equally revealed by its immediately adjacent surrounding space. The flat shape emphasizes the relationship and visual alteration of the contiguous negative space. (Villon may be measuring the width of a negative space.) The isolated study of positive silhouette shape (kept perspectively consistent in relation to the third dimension) and the adjacent surrounding space, offers a relatively quick, accurate means to achieve convincing foreshortening in the measurement of visual depth.

As a technique of observation, focusing on the spaces surrounding objects requires the acquisition of a new perceptual habit. Psychologists interested in visual perception have, with numerous experiments, dramatically refocused visual attention into new perceptual patterns. The technique can be easily demonstrated with a familiar and appropriate example. In an initial response, the accompanying drawing [2-7] is seen as a key. But a shift of focus to the space adjacent to its irregular serrated edge will reveal a familiar profile. This represents a momentary reversal of visual emphasis. Once seen, it is hard to ignore.

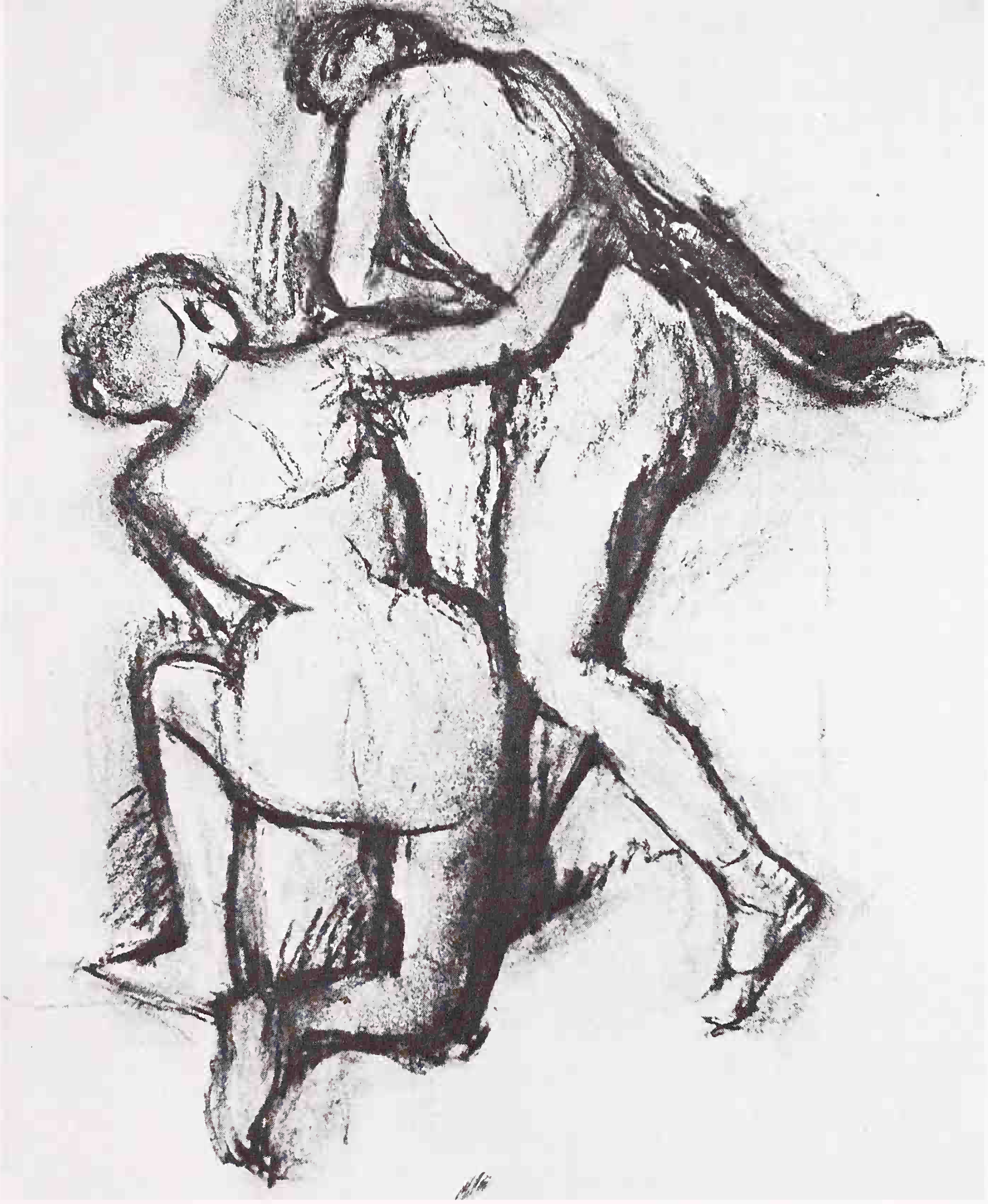
Extending the transfer of visual attention to more complex visual situations can be equally instructive for an understanding of space and form structure. (It is not, however, to play hide-and-seek with Dali-like double images.) Before moving on to the human figure, it will help to illustrate this procedure with a simple three-dimensional object: a chair [2-7] drawn by the spaces enclosed by its various parts, the interstices of the form. By carefully drawing space *A*, a relationship between two legs, a crosspiece, and the seat is immediately established. With the addition of shapes *B* and *C*, the four legs, the seat, and the extended crosspieces have been indicated. It is possible to construct the chair in perspective from this information alone. The direction of the floor plane is implied by the position of the four legs.

The dramatic simplicity of this means of visual measurement in drawing a foreshortened form can be seen in the Degas study [2-8, 2-9]. The relationship between the legs, in the kneeling figure, has been convincingly drawn by careful study of positive form and the somewhat square space enclosed by both bent legs. The shape of this negative space, seen in relation to the hip and the intersection of the vertical inner contour of the calf with the hip and buttock, set the compressed dimensional limit of the foreshortened thigh. This foreshortening of the thigh is confirmed again by shifting attention to the left outer side of the drawing to the shape and angles of the knee, arm, and shoulder.



2-7
The Key, the Chair, and Negative Space.

Viewing the space along the serrated edge of the key will reveal a familiar profile. This gives meaning to the open negative space. Below is a chair drawn by the spaces between the various parts. A relationship between two legs, a cross support, and the seat is immediately established by carefully and precisely drawing space *(A)*. With the addition of space shapes *(B)* and *(C)*, the four legs, the seat, and three crosspieces have been related. It is possible to construct the complete chair by this procedure. The perspective of the floor plane is implied by the position of the four legs.



2-8

2-8

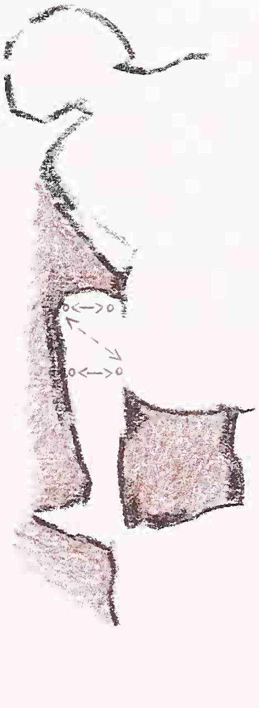
Deux Danseuses en Maillot (charcoal) by Edgar Degas. (Photograph by Durand-Ruel.)

The space between the legs of the kneeling figure (almost a square) and the space outside, to the left of this figure, have been observed with accuracy and provide the visual measurement for the foreshortened thigh.

2-9

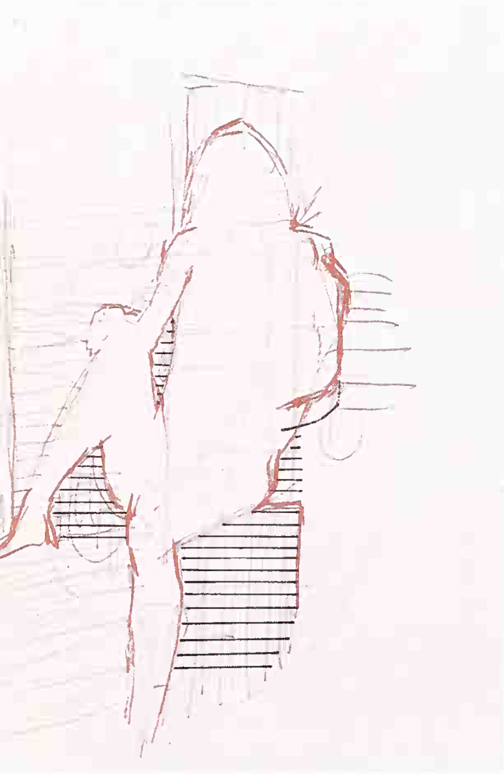
Analysis of Foreshortening.

In the Degas drawing [2-8], the silhouette and the negative spaces (dark areas) have been carefully observed. The two horizontal arrows represent the dimension of the flat silhouette of the thigh. The diagonal arrow represents the axis of the form in perspective (i.e., the foreshortening).



2-9

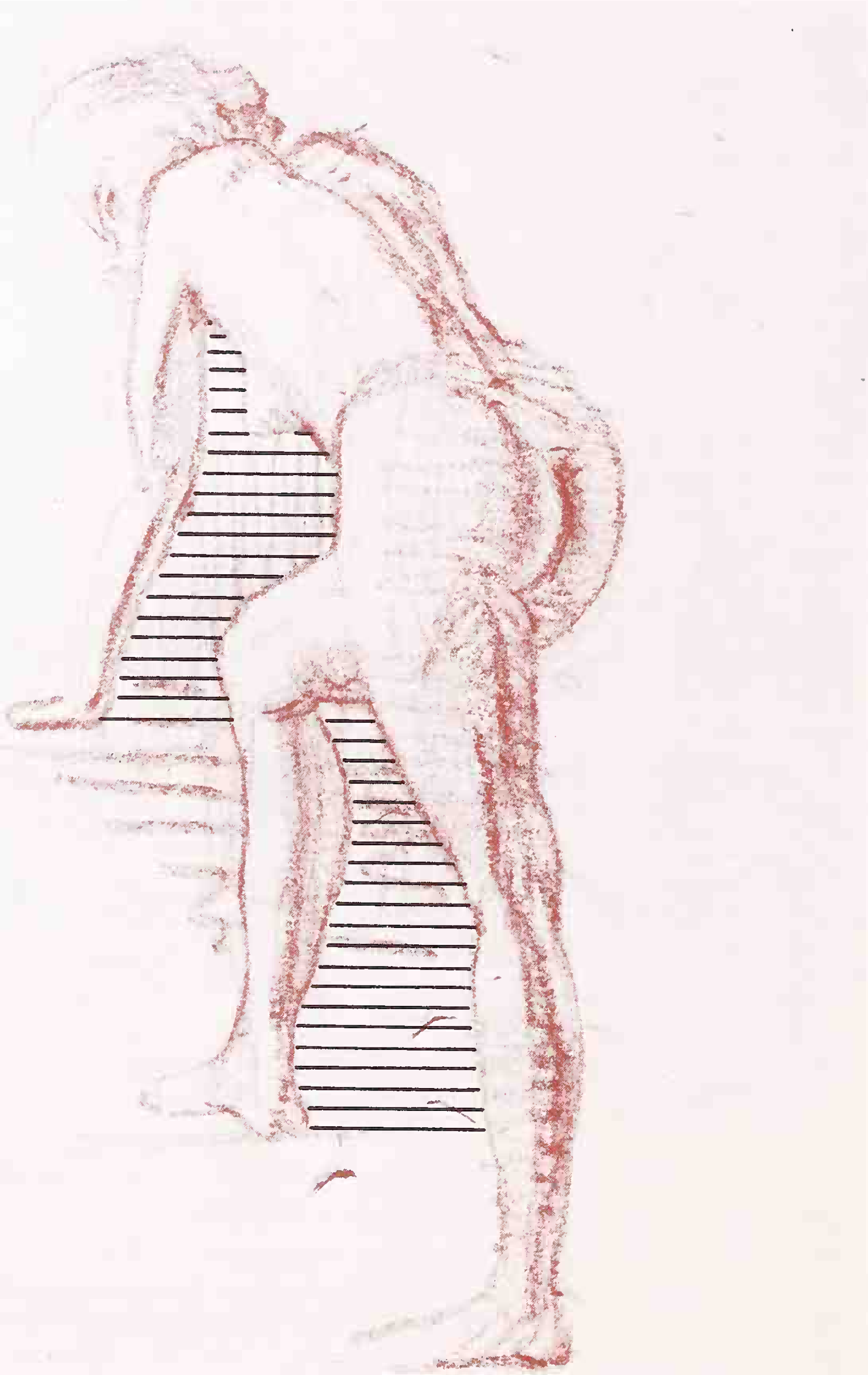
2-10



2-10

Negative Space: No Inner Modeling. Figure by the author. (Photograph by Iso Papo.)

Discipline and restraint curbed the temptation to develop internal modeling at this early stage in the drawing. The seated figure is the result of attention focused exclusively on the interstitial spaces surrounding the form. All points of view are from the contour outward away from the figure to planes behind the model. It is this kind of observation that locks form and space together. This example might be viewed as stage one; illustration 2-11 is stage two in drawing procedure.

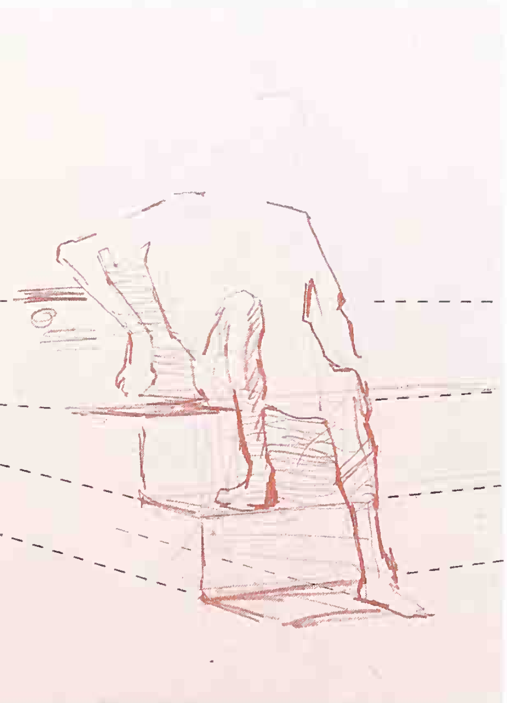


2-11

2-11

The Relationship between Negative Space and Internal Modeling. Figure by the author. (Photograph by Iso Papo.)

Three-dimensional inner volume and two-dimensional silhouette drawing are integrated into a tight, cohesive space. Compare with the Prud'hon nude (illustration 2-16).

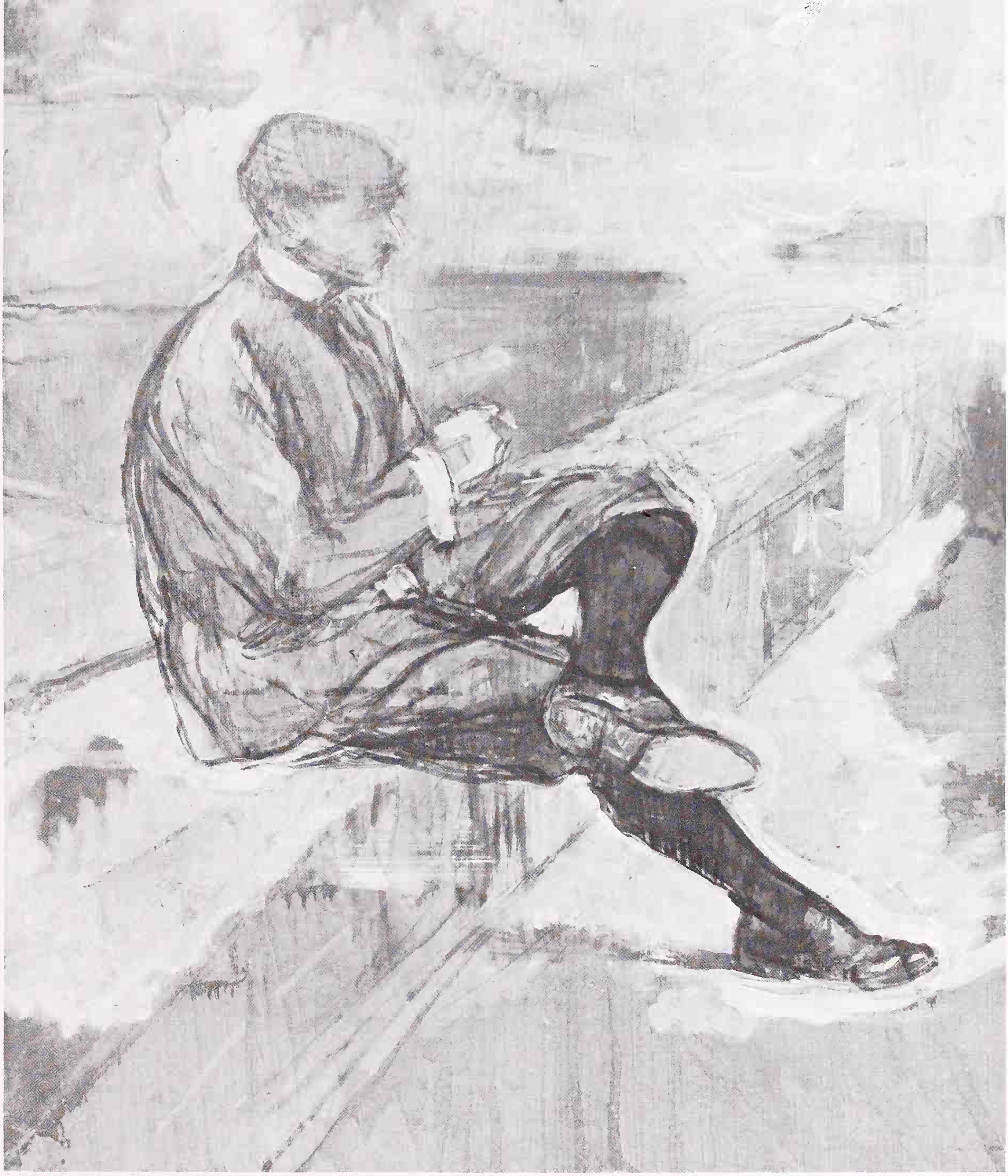


2-12

2-12

Steps and Seated Figure by the author. (Photograph by Iso Papo.)

For this study of interstitial (negative) space and perspective eye-level is at the top step. Drawing the negative space with care plus continual reference and comparison of the top planes of the steps against the figure integrates the figure and steps into a perspectively unified space. The principle of convergence (i.e. perspective three-dimensions) is synthesized with close observation of interstitial space (i.e. two dimensions, silhouette).

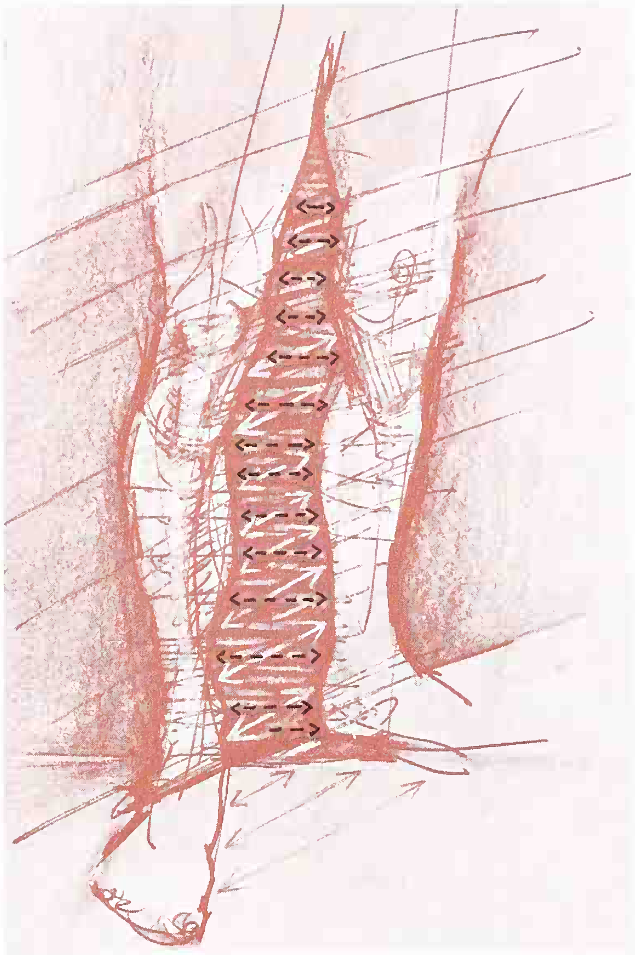


2-13

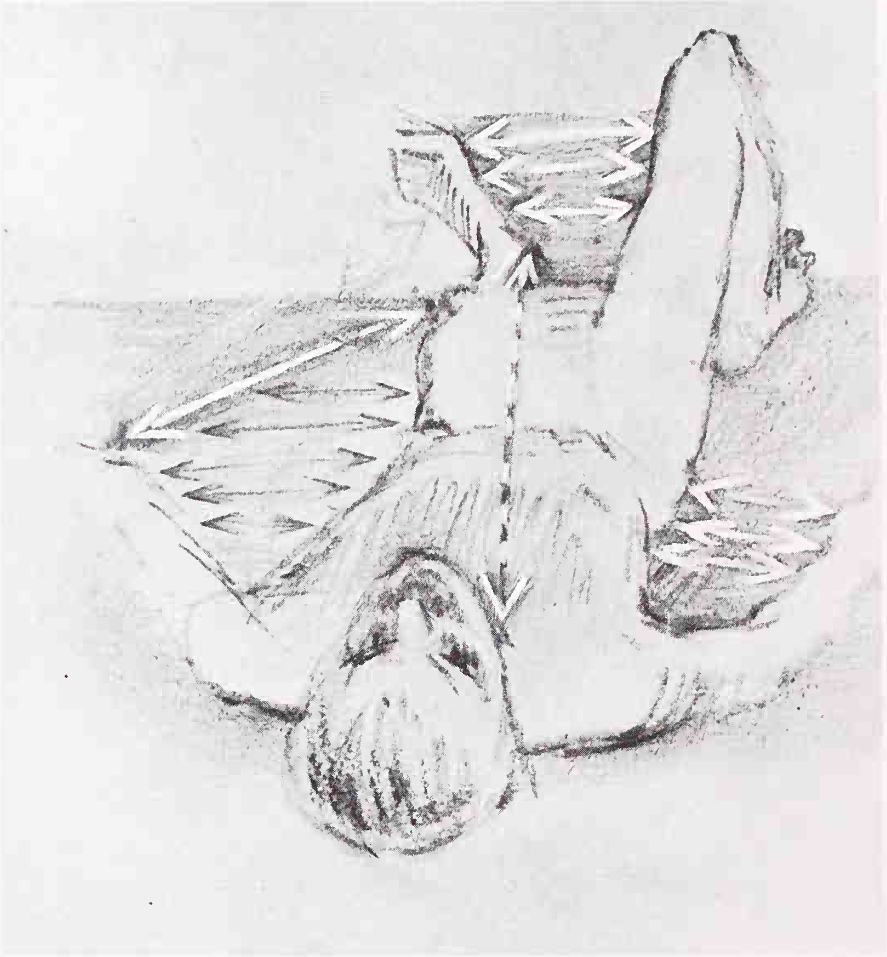
2-13

Portrait of Louis Bougle by Henri de Toulouse Lautrec. (Musée du Louvre, Paris; Cliché des Musées Nationaux.)

The form is defined by the negative space surrounding the figure. The light-colored brushwork painted against the dark silhouetted legs and the top and back of the head reveal Lautrec's integrated vision. The figure shape is defined by its neighboring space as well as internal modeling. Sharp, angular changes of direction are more easily seen by looking "outside" the figure (i.e., the back of the head).



2-14



2-15

2-14

Leg Study (pen and chalk) by the author. (Photograph by Kalman Zabarsky.)

Carefully "drawing" the space between two form units is a means to relate the forms. The light diagonal arrows represent the observation of perspective back into space from the near leg to the far leg. Dark horizontal arrows represent the visual measurement of the narrowness of space. The result is a cohesive relationship between the two forms.

2-15

Foreshortened Figure (pencil) by the author. (Photograph by Kalman Zabarsky.)

This foreshortened figure has been defined by carefully drawing the negative space. This is a simple, accurate means to control foreshortened dimensions. A related procedure was mentioned by Benvenuto Cellini. A lamp was carefully placed near the model to cast a shadow on a whitewashed wall. By drawing the cast shadow on paper, foreshortened lengths were quickly measured. A few added details completed the inner form. Viewing the figure "flat" against its surrounding space is a valuable aid to measurement.

To return for a moment to Villon's *Le Petit Dessinateur* [see 2-6] and an examination of the space enclosed by the face, shoulder, arm, and hand, we will see that the inner dimension of the forearm (wrist to elbow) has been fixed in its foreshortening by this enclosed space (i.e., where the inner limit of the hand visually overlaps the cheekbone). A few additional examples [2-13, 2-14, 2-15] may illuminate the value and utility of precise positive and negative silhouette space study.

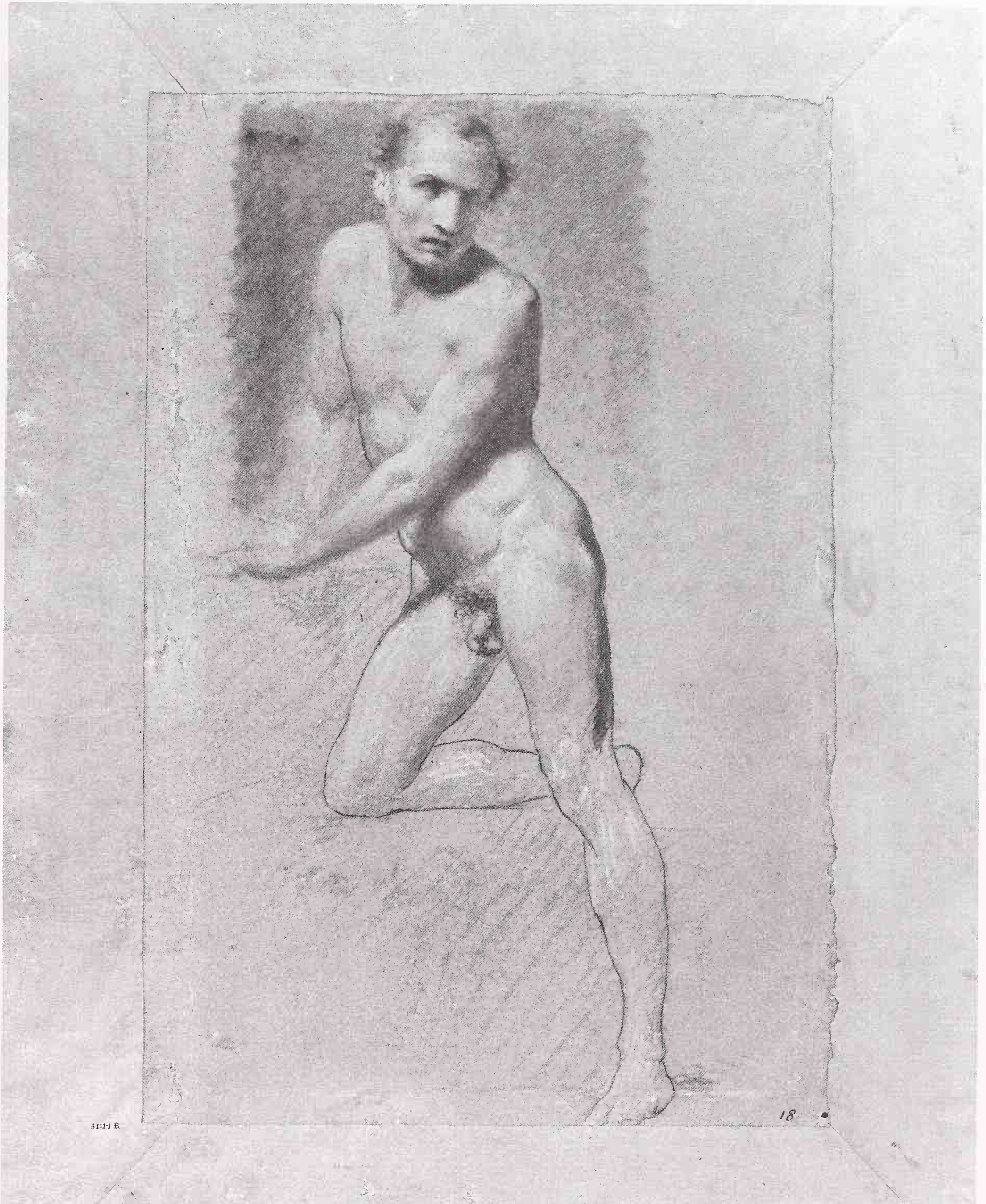
Observations made on both sides of the contour of a form seen alternately as in a three-dimensional and two-dimensional space avoids the danger of drawing forms that are floating and unsubstantial or that are inadequately foreshortened. This also avoids the softening of surface limits (contours) and of contour changes in direction.

The study of the silhouette offers a clearer view of major changes in the direction of the contour of a form. (See the back of the head in Toulouse Lautrec's *Portrait of Louis Bougle* [2-13].) Angular changes in the contour of the cranial form are identified by the brushstrokes of the light-painted areas outside the head.

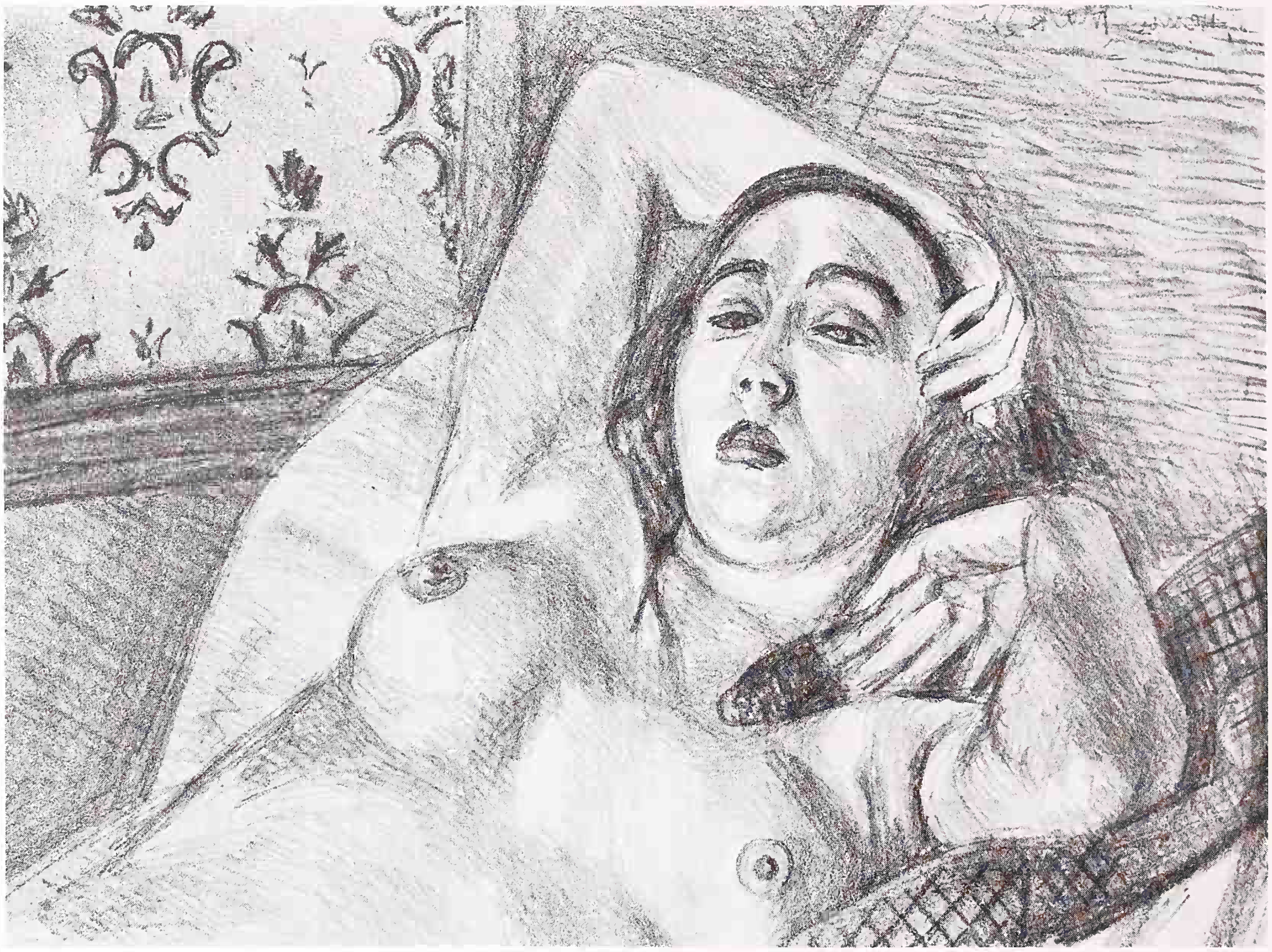
2-16

Meditation by Pierre Paul Prud'hon. (black and white chalk on blue paper) (Smith College Museum of Art, Northampton, Massachusetts; Gift of Julius Weitzner.)

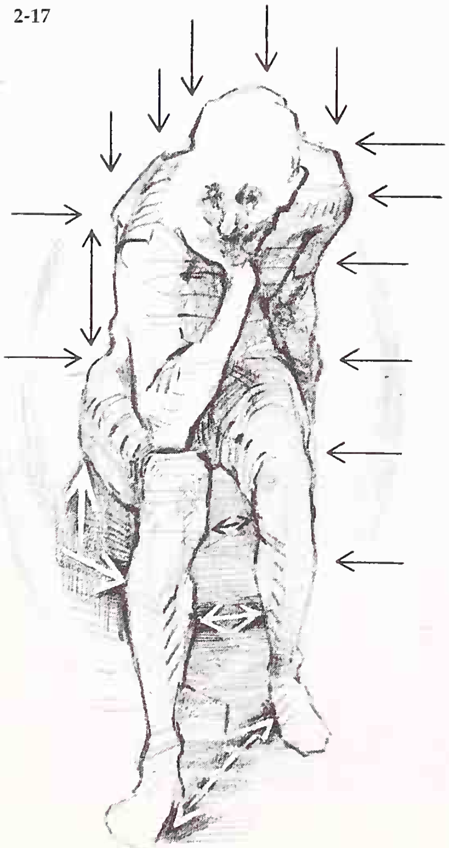
This unfinished study of a male nude is instructive. It clearly indicates Prud'hon's drawing procedure. With charcoal, the artist first established a precise contour drawing, taking into account the relationship between the silhouette and the interstitial spaces (triangle between thighs). White chalk was used to locate highlights. Shadows were firmly located with diagonal lines of charcoal and blended with a "stump," gradually integrating the contour into the sensitive close orchestration of tones associated with the the drawings of Prud'hon.



2-16



2-18



2-17

2-17

Figure Study: Contour and Structure (pencil) by the author. (Photograph by Jonathan Goell.)

Angular changes in the contour were carefully observed by drawing "outside" the figure. Each arrow indicates a change of direction along the edge of the form. These contour angles are carefully coordinated with the structure of planes within the form. In the left leg, the vertical line at the hip is parallel to the verticals at the knee. Coordinated with parallel foreshortened lengths, vertical and horizontal planes are enclosed.

2-18

Repos du Modèle (lithograph) by Henri Matisse. (Museum of Art, Rhode Island School of Design, Providence.)

In this lithograph, foreshortening is admirably demonstrated. Note especially the convincing thrust of the compressed planes in the sharply foreshortened arm.

Focusing on the spaces around forms is a perceptually deliberate act of visual attention. It has to be learned. Often the inexperienced student forgets to consider this problem of relationships when he is faced with a complex form or a group of closely associated forms. Practice can make this easier. For the student, it is advisable to carry out a series of drawings dealing precisely and carefully with the silhouette and negative (interstitial) space. He can then integrate this exercise with the observation and analysis of three-dimensional relationships. The coherence this provides among the various parts of the figure is almost immediately apparent. Analyzed and diagramed drawings [2-17, 2-18] are included for additional study. The study of such illustrations should be supported by repeated concentrated drawing from the figure. (Though not directly related to the problem of foreshortening in figure drawing, it is worth noting that the careful drawing of negative spaces is very useful in establishing scale and distance between near and far forms, as in a large interior space or in a landscape, or the scale between two figures in the line of sight, one near, the other distant.)

PART TWO: ANATOMY AND STRUCTURE

INTRODUCTION TO PART TWO

> *I have always endeavored to express the inner feelings by the mobility of the muscles.*
>
> Rodin

To be useful, surface anatomy applied to figure drawing must be necessarily selective. Attempts to clutter the memory with indiscriminate anatomical detail will only frustrate the artist. For example, irregular sutural divisions in the skull have no influence on surface form. Numerous irregularities in bone structure and many minor muscles have no direct relevance for figure drawing. Nor will memorizing complex anatomical nomenclature, by itself, improve drawing skills. But the significant facts of surface anatomy can be examined to good advantage. Combined with active drawing from the model, the study of anatomy will contribute to improved and confident drawing.

Organizing a great mass of factual detail is not easy. Properly understood, knowledge of nomenclature will facilitate the location and organization of muscles and bones.

The skeleton is made up of over 200 bones that serve as an internal supporting framework. The symmetry of the figure is organized around a central axial skeleton and the paired components of the appendicular skeleton. The axial skeleton is composed of the skull, spinal column, and rib cage. It offers protection and support to internal organs. The appendicular skeleton is composed of the bones of the upper and lower limbs (including the shoulder girdle and pelvic girdle). They are arranged to act as levers and permit extensive movement.

The bones are classified according to their shape:

Long bones: the bones of the arm and leg (humerus or femur).
Short bones: the bones of wrist and ankle (carpus and tarsus).
Flat bones: the bones of the shoulder (scapula) or skull (parietal).
Irregular bones: the vertebrae or hip bones.

MUSCLE AND TENDON

The specialized body tissue that is the agent of movement is voluntary (striated) muscle tissue. A select group of muscles directly or indirectly affect the surface form of the figure. Skeletal muscle makes up the major part of the body mass and is important for study by the artist.

Voluntary muscle does not attach directly to bone. It is attached to the skeleton by tendons. Tendon is strong, inelastic, passive tissue and remains relaxed until tightened by the contraction of muscle. Tensing the fingers will reveal tendon cords on the back of the hand. Tendon may also be ribbonlike or sheetlike in form (aponeurotic tendon).

MOVEMENT OF MUSCLE

In this text the description of movement relates to the primary function of bones and muscles. Beyond these essential actions are numerous additional, supportive, and subtle muscle exertions related to almost any gesture of the figure. It is beyond the scope of this text to dwell on the secondary exercise of articulations and muscles.

Many subordinate actions of bones and muscles can be deduced from their primary function. A knowledge of the origin and insertion will suggest these secondary actions. For example, raising an arm activates muscles on the front and back of the torso (i.e., the chest [pectoral] muscle and the upper and lower back muscles), even though the primary abductor to raise the arm is the deltoid muscle at the shoulder.

NOMENCLATURE

Skeleton

A knowledge of the names of the bones and muscles will assist the artist in the study of anatomy. For example, skeletal terms may include the name of a muscle. The tibialis anticus is named for part of its bony attachment, the tibia (shinbone).

The bones often derive their names from a similarity to another real form. For example, the word *clavicle* (collarbone) comes from the Latin for ''little key,'' and *tibia* (shinbone) means ''flute.''

Some bones are named for an action. The mandible (jawbone) derives its name from the Latin, ''to chew.'' Other bones take their names from their location, for example, the frontal bone at the front of the cranium.

Muscles

Various considerations contribute to the names of muscles. Some basic guidelines should help in remembering these terms.

The principle sources for muscle names are:

1. The *action* of a muscle: for example, levator scapulae, or ''lifter of shoulder blade''; or the facial expression created by the action of a muscle: risorius, or laughing muscle.
2. The *shape:* the serratus, or sawtooth muscle.
3. The *resemblance* to another object: the soleus looks like the fish, the sole.
4. The *location:* the subclavius, or muscle under the clavicle.
5. The *attachments:* the sterno-cleido-mastoid, or the muscle attaching to the sternum (breastbone), clavicle (collarbone), and mastoid process (part of temporal bone).
6. The *size:* the latissimus dorsi, or the ''broadest'' muscle.
7. The number of *parts:* the biceps, or two-headed muscle or the triceps (three-headed).
8. The *direction* (of the fibers): the rectus, or straight muscle and the external oblique, or diagonal or slanting muscle.
9. The *occupation* in which the muscle is considered useful: the sartorius, or tailor's muscle; the buccinator, or trumpeter's muscle.
10. Relative *proportion* of muscle to tendon: the semitendinosus, or half-tendon muscle.

Anatomical Movement

A few important terms of movement must be emphasized as clearly anatomical and paired as antagonistic, one to the other.

flexion (a bending): one part bent upon another.
extension (a stretching): a straightening of a part with another.
abduction (a drawing from): moving a part away from the midline.
adduction (a drawing to): a movement back toward the midline.
pronation (a bending forward): a movement that turns a part on its face or palm down.
supination (lying on the back): a movement turning palm up.

THE HEAD AND THE FEATURES

Skull

BONES OF THE CRANIUM
frontal
parietal
temporal (mastoid process)
occipital
BONES OF THE FACE

frontal eminence	of the frontal bone
superciliary eminence	
glabella	

zygomatic (malar)
zygomatic arch
maxilla
mandible
nasal

Head Muscles

occipito-frontalis
temporalis
orbicularis oculi
corrugator supercilii
  (causes a frown)
levator palpebrae
procerus
nasalis
orbicularis orias

buccinator	muscles of expression acting on the orbicularis oris
risorius	
triangularis	

quadratus labii inferioris
mentalis
angular head
zygomaticus minor
zygomaticus major
infra-orbital head
masseter

CHAPTER 3

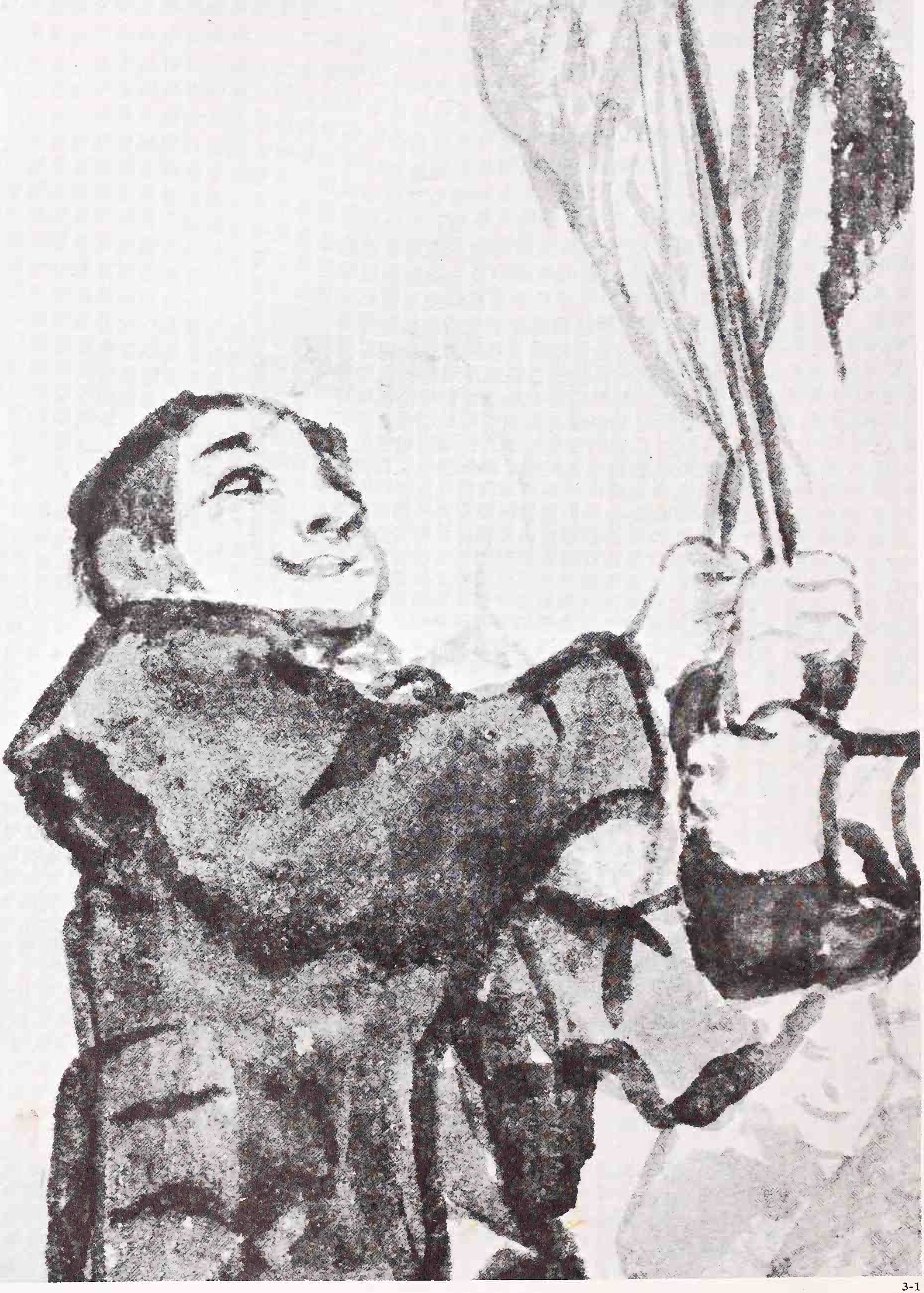
THE HEAD, FEATURES, AND HAIR

No form exerts a greater fascination than the human countenance. It is the initial point of contact in human communication and the focus of continuous interest, both intellectual and emotional. But, in spite of its familiarity and the generous attention it receives, it can be reckoned a problem to discerning observation in drawing.

Few forms present more misleading clues to space and structure than the head and its many prominent units. "Character" wrinkles, decorative markings like the eyebrows, and the "linearity" of the features tend to camouflage the substantial planes of the face. The unique importance of the features may cause them to be seen separately, in a manner that ignores their interrelationship or obliterates their larger cranial and skeletal context. It is essential to see beyond the individual features—to get behind the veneer of deceptive detail and to discover the substance of significant surface and volume. Awareness of anatomy will help. But it too presents a vast and complex array of individual elements.

The selection of a number of key anatomic limits, organically precise, is a first essential step. This disposition of selective major anatomic relationships, positioned before attention is given to the smaller organic anatomic details, may be graphically identified (by the point)—for instance, the distance between the cheekbones and their relation to the chin and the angle of the jaw. Axes running the length of the form and those extending across, at the forehead and through the features, may be tied into this framework. Over this initially measured abstracted ground plan (carried out to include cranial dimensions), the recognizable units of detail may be superimposed and organically integrated. As a process, these groupings may, with experience, be joined; and broad location and detail may be seen and drawn together in a single synthesized statement [3-1].

A comparison of illustrations 3-2 and 3-3 indicates that there are sizable anatomic relationships in the skull structure. The locational and directional significance of these larger planes is diagramed to show their influence. The most careful attention should be lavished on these big spatial connections. It is precisely at this early stage of observation, in the abstraction of wide positions, that form and "character" meet at their most significant level. It is at this stage that a true "likeness" is achieved by the tension of lengths, axes, and angles seen beneath and through the features.

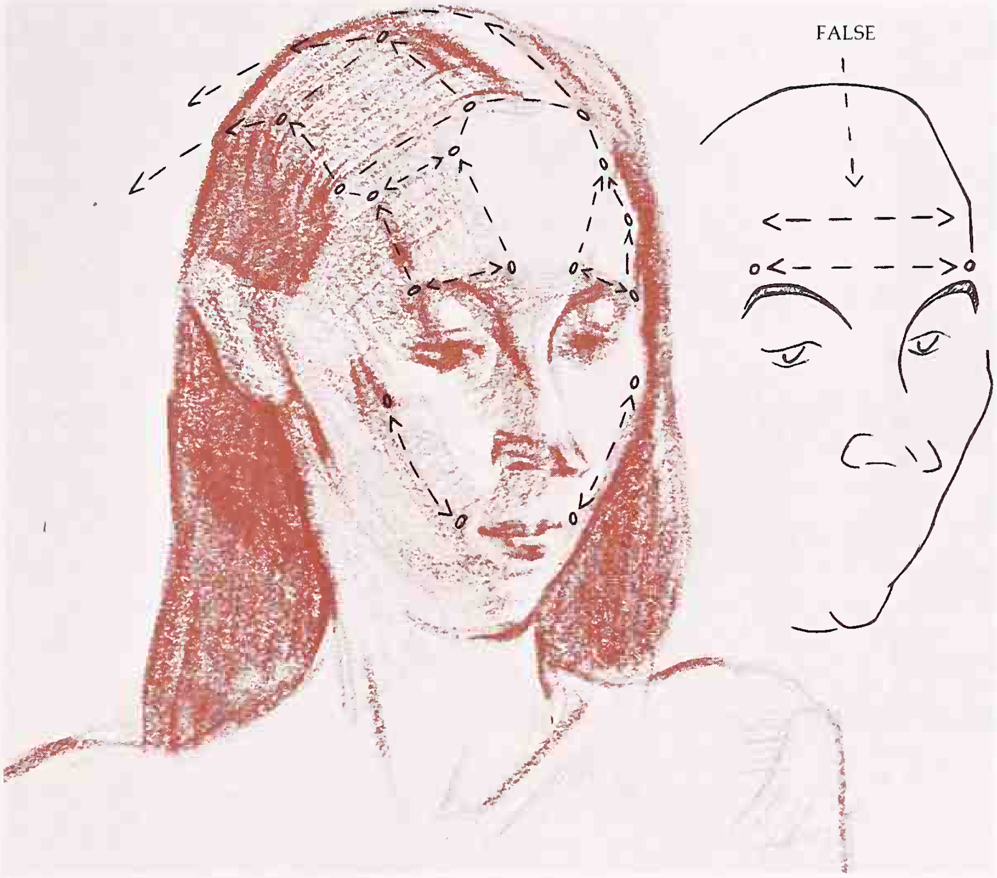


3-1

3-1

Detail of Provincial Dance by Francisco de Goya. (The Metropolitan Museum of Art; Harry Brisbane Dick Fund, 1935).

The blocklike side and front planes of the head are echoed in the angle at the shoulder and the broad planes of the upper arm. The features are perspectively consistent within the head and with the upper torso. (See illustration 2-4 for the complete drawing.)



3-2

3-2

Head of a Girl (crayon) by the author. (Photograph by Kalman Zabarsky.)

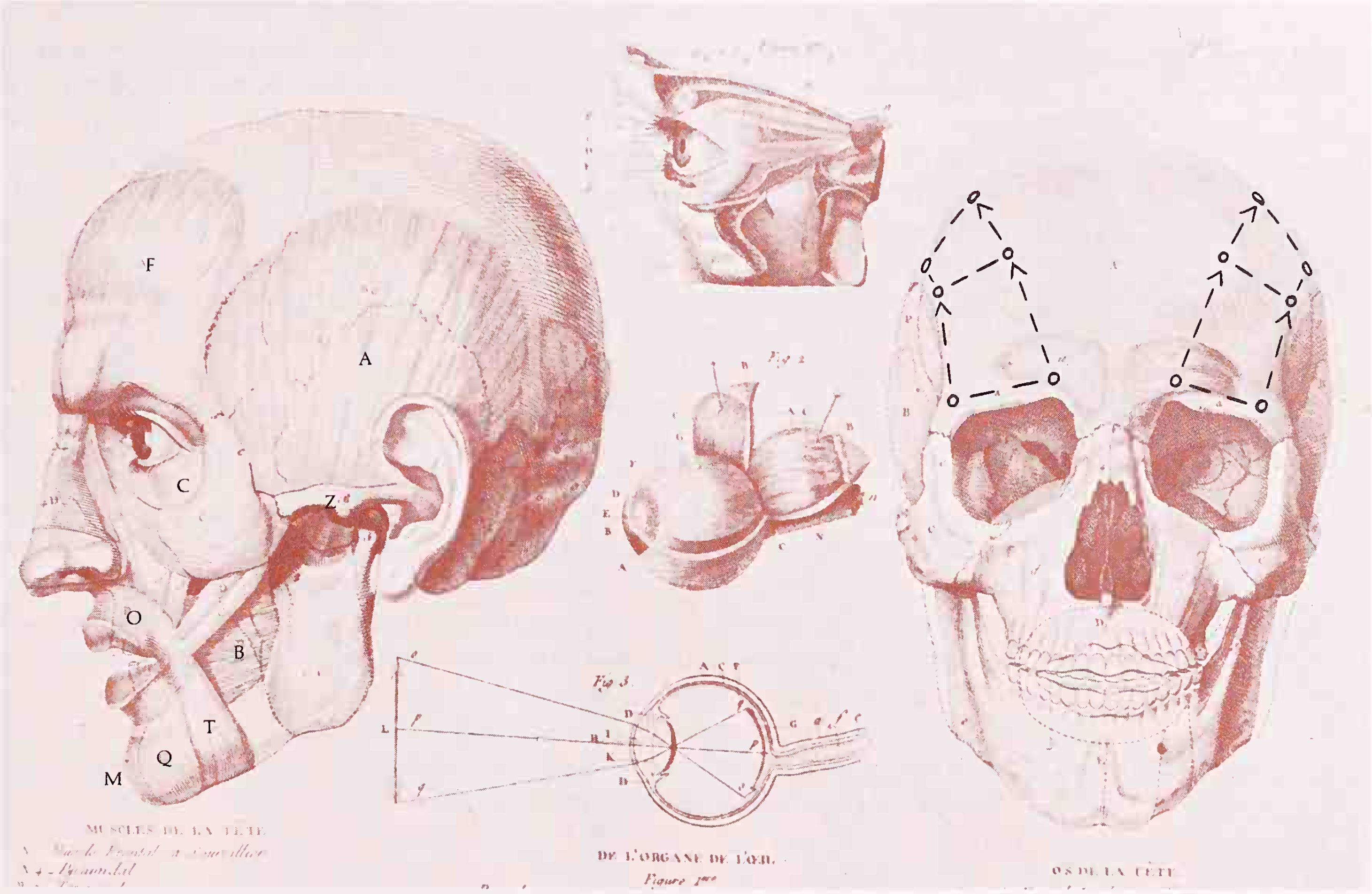
The planes of the forehead (frontal bone) are frequently falsified when the eyebrows are used to define its lower border. A more authentic guide is the direction of the eye cavity. The upper edge of this cavity, running beneath the eyebrow, rarely coincides with it. This less obvious upper margin of the eye cavity marks the true origin of planes in the forehead, continuing over the top of the skull, under the hair mass, to the back of the skull. (Compare this illustration with the skull by Salvage [3-3] and the one by Cloquet [3-13.] Below the eyes, the zygomaticus major muscle extends from the cheekbone to the corner of the mouth and frames the large triangular plane of the front of the face, separate from the vertical side planes.

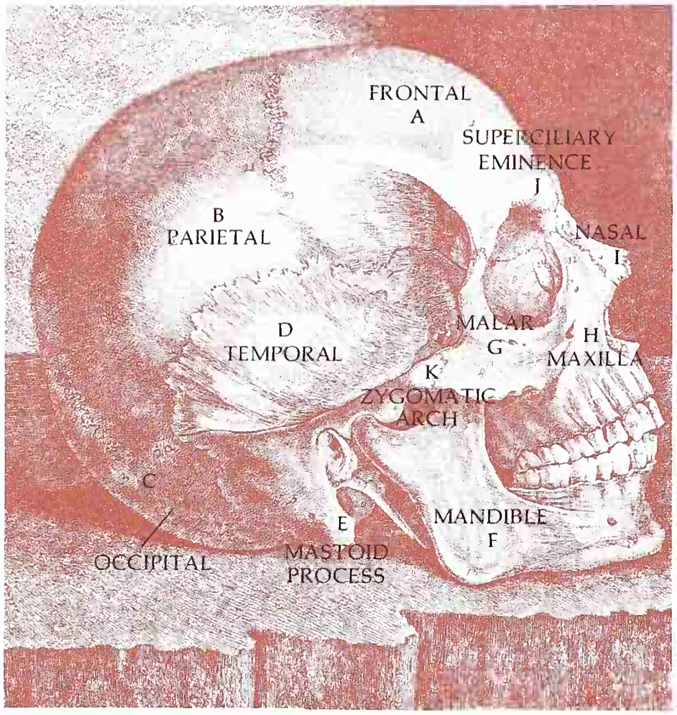
3-3

Skull: Front View, from Anatomy of Bones and Muscles, Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

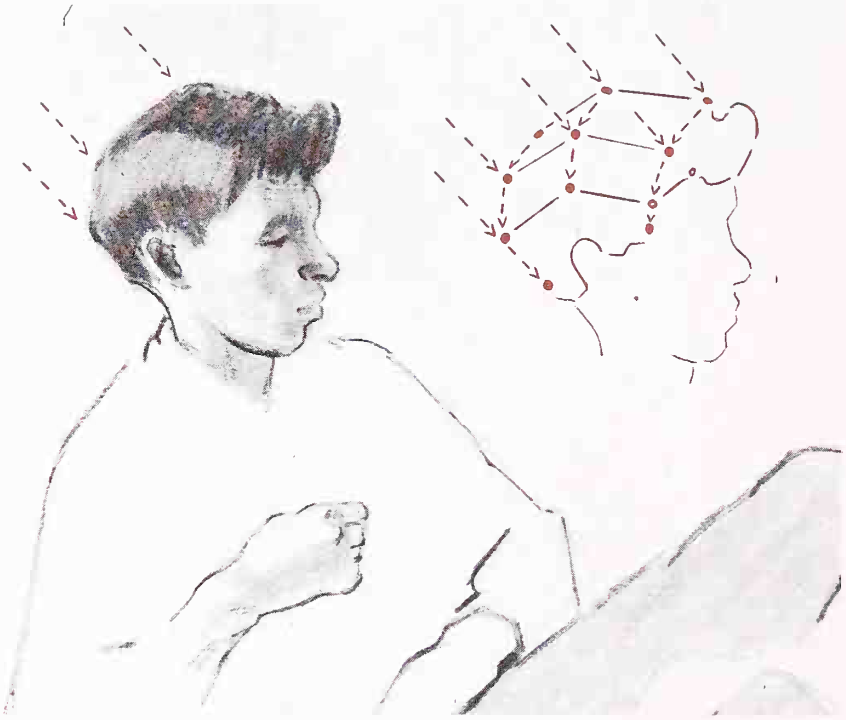
The diagonal planes of the cranial structure begin at the upper limit of the eye cavity. These planes continue into the cranium to the back of the skull. The eyebrow usually conceals the direction of this edge and can distort (flatten) the plane above. Identified on the profile of the head are the following: occipito frontalis *(F)*; temporalis *(A)*; zygomatic arch *(Z)*; buccinator *(B)*; triangularis *(T)*; quadratus labii inferioris *(Q)*; mentalis *(M)*; orbicularis oris *(O)*; orbicularis oculi *(C)*.

3-3





3-4



3-5

3-4
Skull, from Twenty Plates of the Osteology and Myology of the Hand, Foot, and Head by Antonio Cattani. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Jonathan Goell.)

The dimension of the large cranial dome should be carefully compared with the small mask of the face. While head proportions vary, the cranial volume is the dominant form. In drawing, small details tend to expand in scale at the expense of large, simple forms. So, individual features, as they are closely examined and drawn, may grow larger and eliminate or minimize simple surfaces and ample volumes. The skull is composed of several bones and processes. As seen in this illustration, they are: frontal *(A)*; parietal *(B)*; occipital *(C)*; temporal *(D)*; mastoid process *(E)*; mandible *(F)*; malar *(G)*; maxilla *(H)*; nasal *(I)*; superciliary eminence *(J)*; zygomatic arch *(K)*.

3-5
Figure Drawing by the author. (Photograph by Ronald Lubin.)

In drawing the hair mass, changes in direction can be tied to important surface changes within the form. This is usually revealed in the parallel movement of highlights and contour of the face.

Yet it is precisely this level of measurement that is so frequently ignored in drawing. The inexperienced eye responds with astonishing relish to an out-of-context detail—the curve of a nostril or an isolated wrinkle. Unfortunately, the premature cataloging of small detail can result in overall spatial chaos. The observer cannot "read" his way into a coherent and selectively ordered form. Therefore, small detail should be set apart in favor of carefully calculated, related, broad spatial positions. Once these inclusive locations have been well observed and are perspectively consistent, "meaningful" accessories can be developed with some confidence.

A complicated, disheveled hair mass can disguise its own scale and overall unity. Drawn too small, the hair can frame the face with a broken irregular border that has no relation to the planes of the head. The face can appear to be an empty mask without substance or weight. This may result from a lack of careful consideration of the scale of the larger cranial form above and behind the features. In his memoirs, Cellini makes the point in a trenchant comment on a sculpture by Bandinelli: "If the hair of your Hercules were shaved off, there would not remain skull enough to hold his brains."

Study of a side view of the skull compared with the frame of space occupied by the features will quickly reveal the importance of the cranial mass [3-4]. The largeness of this form is less obvious from the front. It should not be ignored, however. The planes can often be clearly seen beneath the hair mass projecting to the back of the skull. The widest part of the skull—the parietal eminences—affect the bend of planes on top, side, and back, in turn influencing the broad form of the hair mass [3-5]. (In studying the skull, the sutures—the sawtooth connections between the bones—should not be stressed. They have no influence on the form.)

THE FOREHEAD

The cranial structure of the head is dominated by the bones. The muscles of the cranium are stretched thinly over the frontal bone, following closely the hard surface of its curved eminences. In the cranium, the bones determine the form and influence the shape of the hair covering. (The temporal, parietal, and occipital bones make up this large, usually enveloped volume [3-4].)

The most visible bone of the cranium, the frontal bone of the forehead, seems deceptively simple. But subtle eminences and the camouflage of skin wrinkles and an irregular hairline can easily mislead even the most alert observer. The rounded frontal eminences and the projecting superciliary ridge, bordering the top of the eye cavity, must be seen in relation to a larger surface development. (See illustration 3-3.)

The planes of the forehead are limited, below, by the angle of the upper borders of the eye cavities. Superficially, the hair of the eyebrow would seem an obvious and logical indication of this boundary. But the direction of the eyebrow and the direction of the eye cavity rarely, if ever, coincide. In fact, the eyebrow usually hides the true direction of the upper limit of the cavities and the angle of the important planes of the forehead. If one is guided by the eyebrow, the forehead will be distorted into one flat, even plane. The truer, but less obvious, limit runs beneath this at the upper margin of the eye cavity, the two diagonal ridges of both cavities meeting above the nasal bone, joining into the glabella (nasal eminence of the frontal bone). This frequently distorted order of large planes is shown in illustrations 3-2 and 3-3.

The glabella is a clearly identifiable triangular wedge of bone surface between the eye cavities just above the two small nasal bones. Like the keystone at the center of an arch, it can function as a visual anchor to hold the eyes in place. It is identified in the illustration here [3-7] and may also clearly be seen in two other illustrations of the skull, one shown from the front [3-3] and the other, from the side [3-4]. Superficially, the glabella may occasionally be divided by frown lines or hidden by heavy eyebrows.

PLANES OF THE FACE

Relationships between the cheekbone and mouth (and chin) are crucial to an understanding of the planes that make up the front and side of the face. Linear diagonal creases beneath the eye and beside the nose can obscure the more important (but often less obvious) opposing thrust of the zygomatic muscles running from the cheek to the corner of the mouth [3-7]. It is these two thin muscles that form the margin between the front of the face (below the eyes) and the transitional vertical side plane above the jawbone from the chin to the front edge of the masseter muscle. (In fleshy, full-cheeked individuals, the change is very subtle. In elderly persons, wrinkles and slack muscles may obscure this relationship.)

The cheekbone (malar) is again the pivot for a major surface connection that moves diagonally back to the angle of the jaw. (See illustrations 3-9 through 3-12.) This cheek-to-jaw division is caused by the masseter muscle (padded by the parotid gland), which occupies the area below the zygomatic arch, filling out the form to the rear vertical limit of the jawbone (ramus of the mandible).

3-6

Superficial Muscles of Head and Neck, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The muscles of expression, the small muscles of the face, communicate emotion. These muscles are unique. Unlike other muscles that attach between two or more bones, the facial muscles originate from bone but insert into other muscle (primarily the muscle around the lips).

3-7

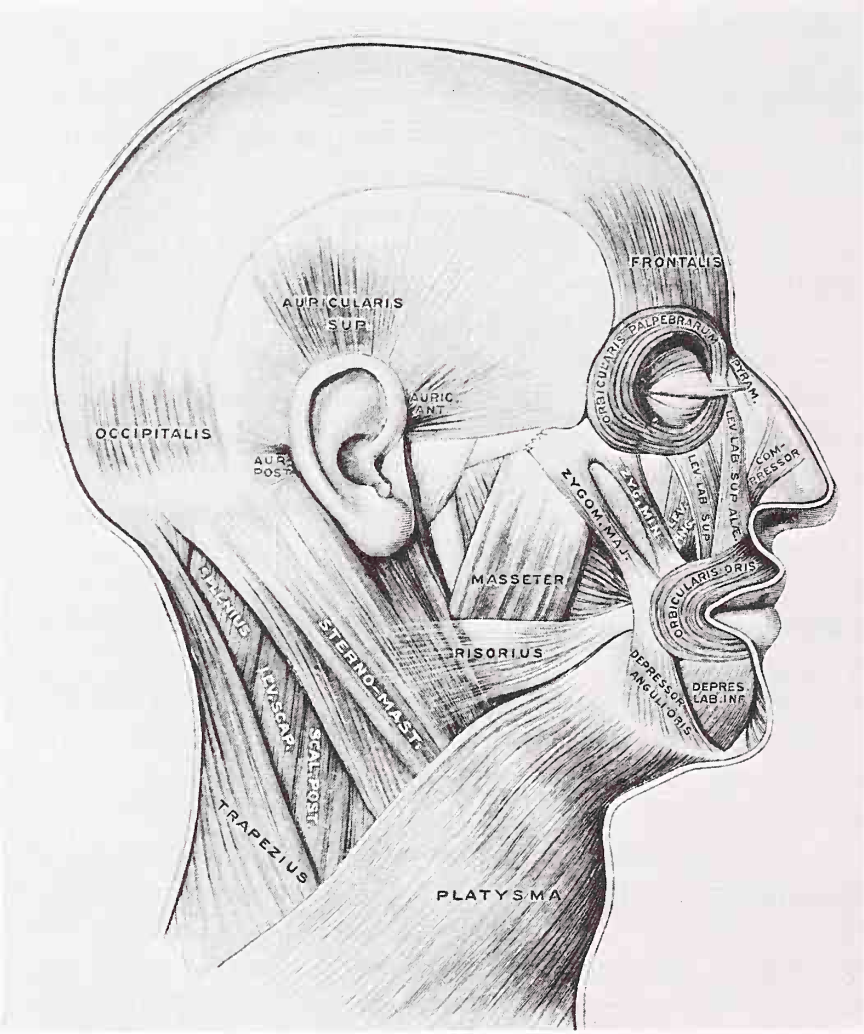
Skull (crayon and wash) by the author. (Photograph by Kalman Zabarsky.)

The zygomaticus muscle (major and minor) and the masseter muscle have a prominent influence on the planes of the face. From the cheekbone to the corner of the mouth, the zygomaticus *(Z)* separates the front plane of the face below the eyes from the vertical side plane. The masseter muscle *(M)* emphasizes the side of the head from the cheekbone to the angle of the jaw. (Compare the delineation of this muscle with its description in the painting by Degas [3-10.] The wedge-shaped glabella *(G)* is a useful plane to help align the eye cavities and the eyes.

3-8

The Mandible, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The two processes of bone crowning the ramus of the mandible have two distinct functions: the rounded condyle articulates with the temporal bone above; and the pointed coronoid process is for the attachment of the temporalis muscle to close the jaw.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AURIC. ANT.
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AUR. POST.
COM-PRESSOR
LEV. LAB. SUP. ALÆ
LEV. LAB. SUP.
ZYGOM. MIN.
ZYGOM. MAJ.
LEV. ANG.
MASSETER
ORBICULARIS ORIS
SPLENIUS
STERNO-MAST.
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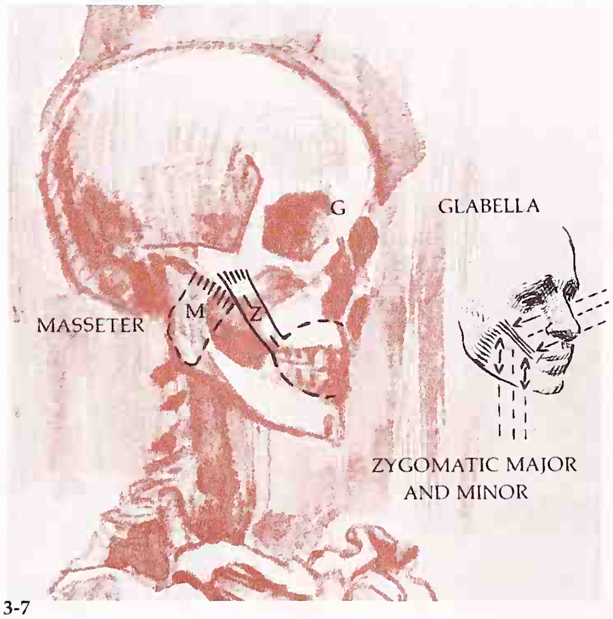
SCAL. POST.
TRAPEZIUS
PLATYSMA

3-6


G
GLABELLA
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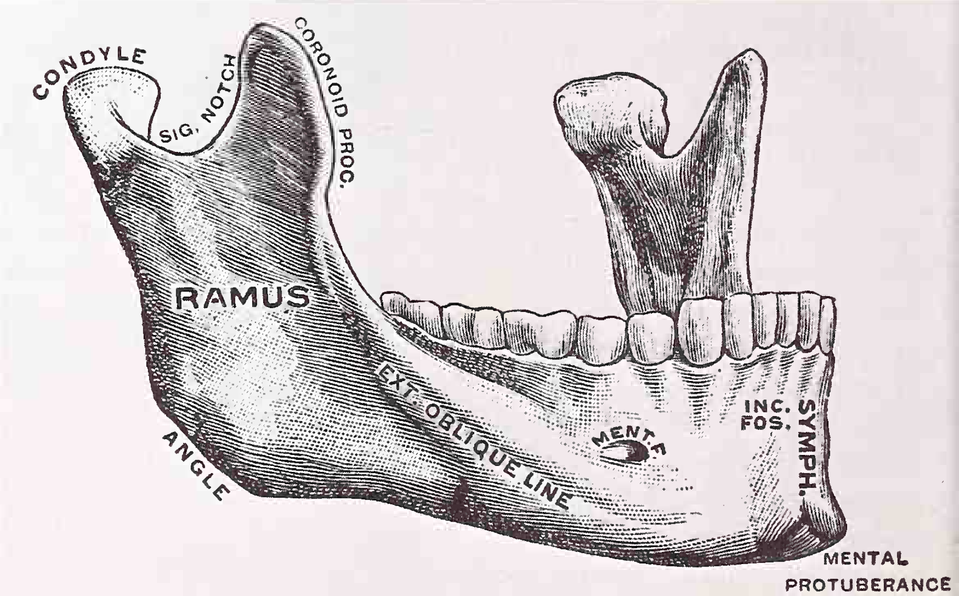
Z
ZYGOMATIC MAJOR
AND MINOR

3-7


CONDYLE
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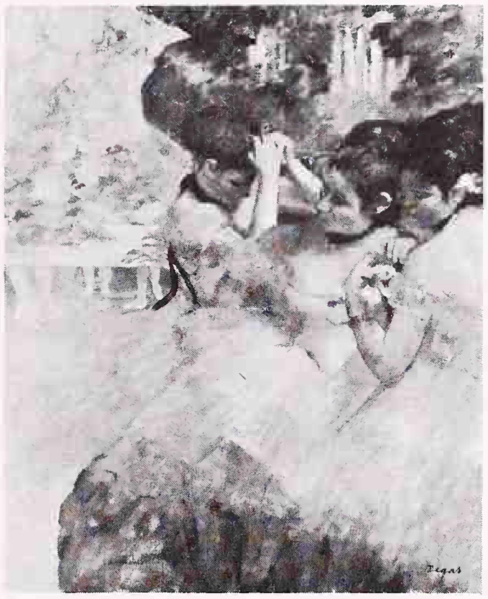
3-8



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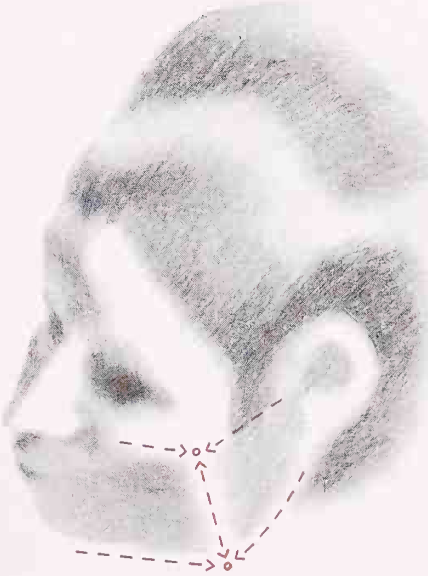
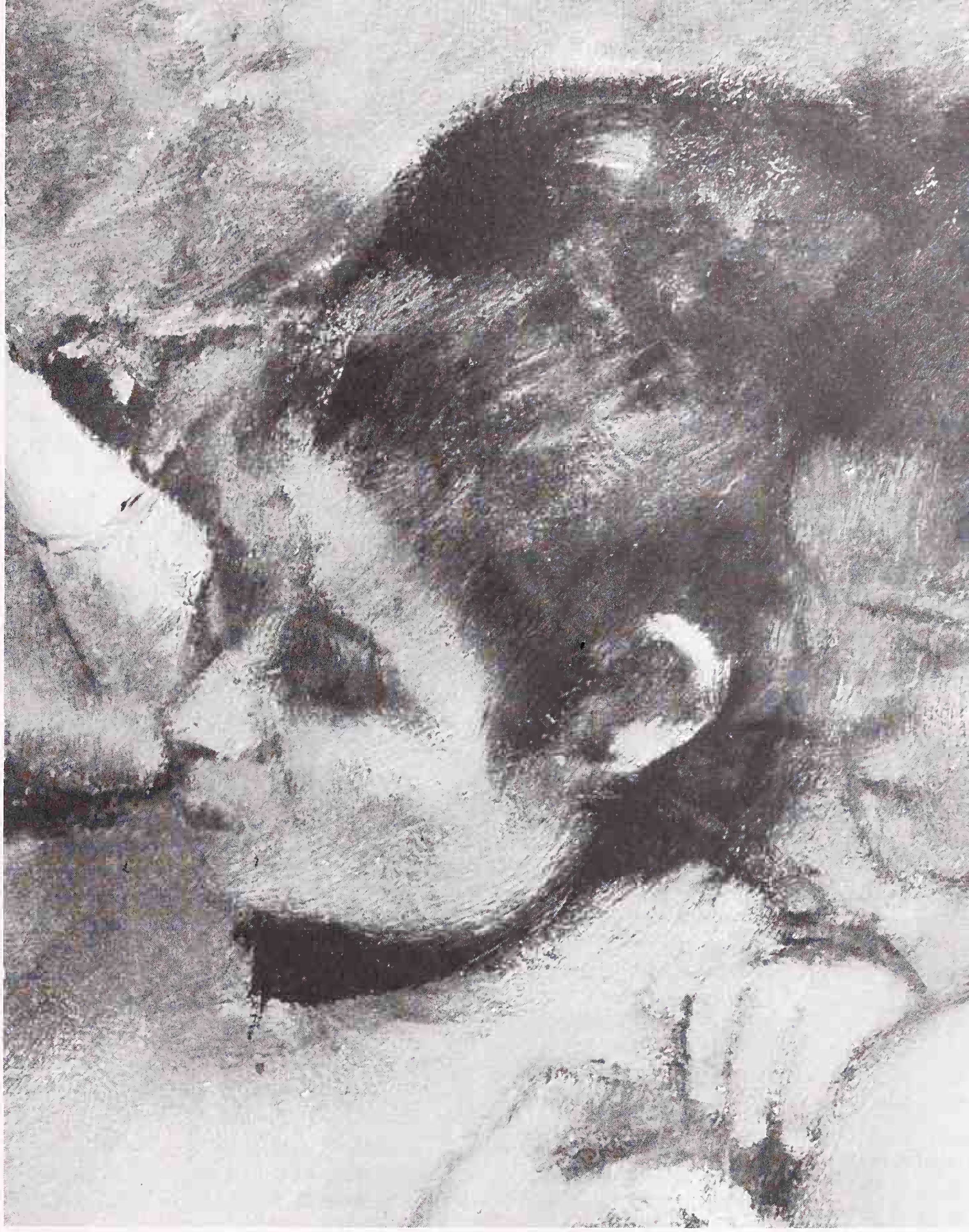


3-11



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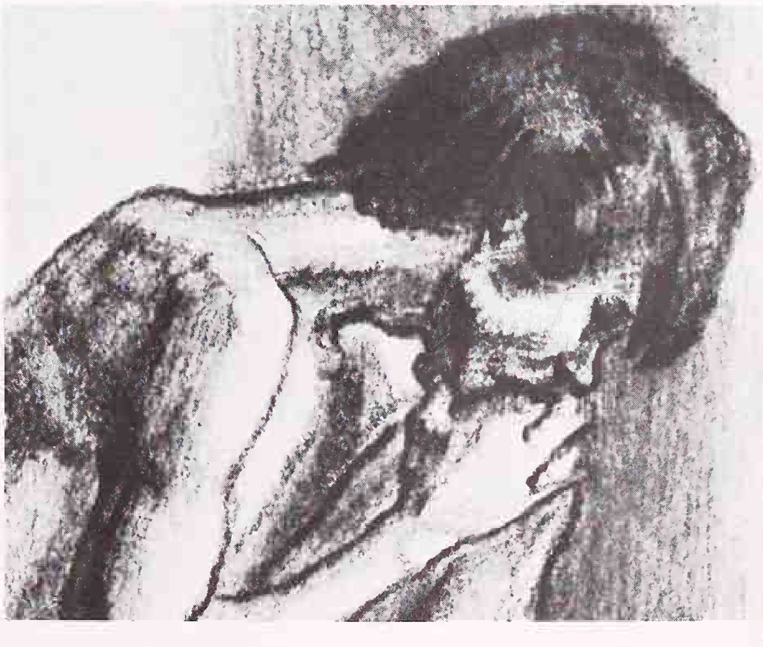
3-12



3-9
Dancers Preparing for the Ballet (oil on canvas) by Edgar Degas. (Courtesy: Art Institute of Chicago.)

3-10
Detail from Dancers Preparing for the Ballet by Edgar Degas.

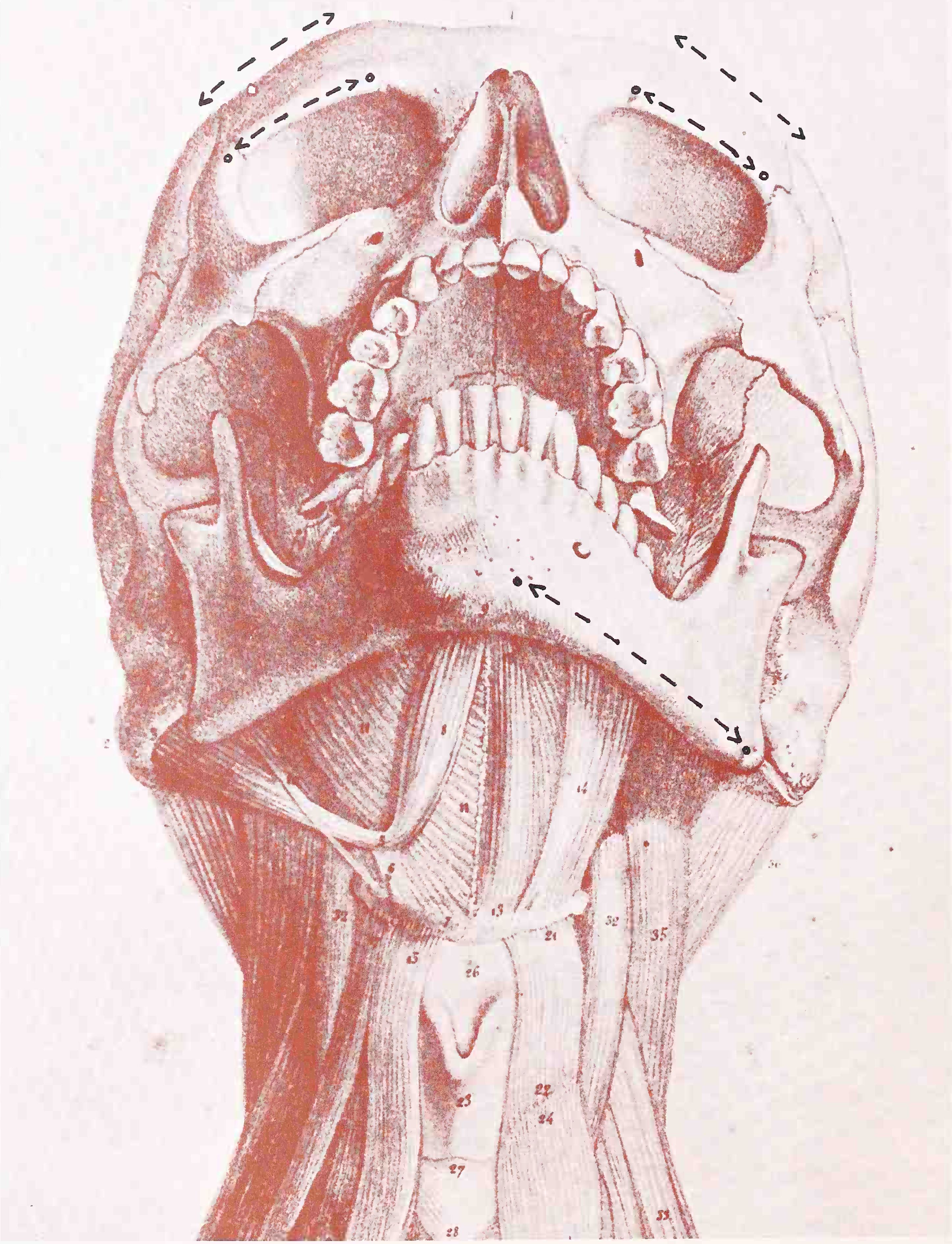
In this enlarged detail, one can see clearly the planes of the side of the face formed by the jawbone, the cheekbones, and the masseter muscle. (Compare this with illustrations 3-5 and 3-11.)

3-11
Analysis of Facial Planes.

This analysis of the detail of the painting by Degas [3-10] shows the planes of the side of the face. The planes join along the masseter muscle from the cheek to the angle of the jaw.

3-12
Detail from Figure Study (crayon) by the author. (Photograph by Kalman Zabarsky.)

The jaw structure and the masseter muscle are strongly defined as a side plane on the head. Sharp angular changes may be seen from jaw to chin and in the cheek plane.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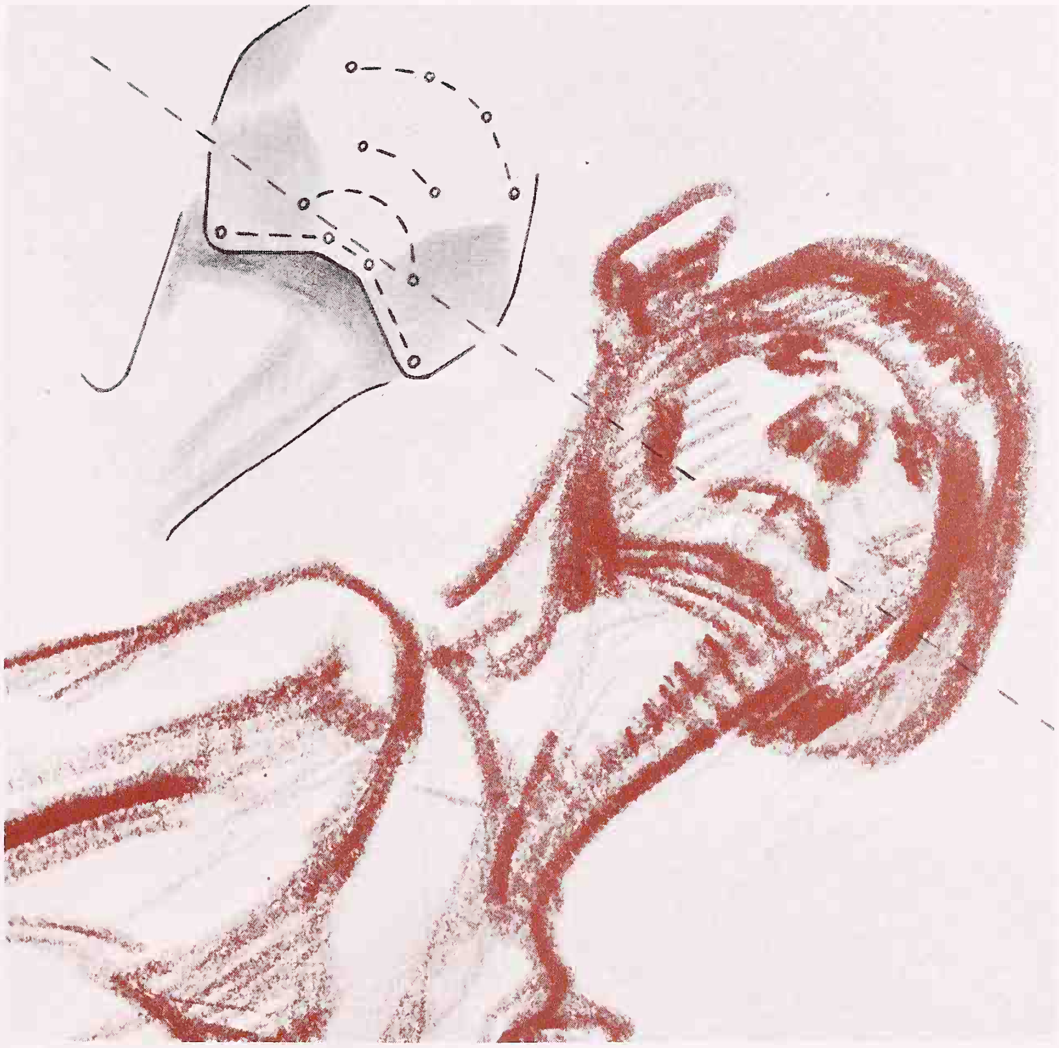
3-13

AXES OF THE FACE

Axes running through the features from one side of the head to the other are too frequently reduced to a straight direction. Forms, like the eyes, aligned on such a rigid straight axis, look stiff and mechanical because such an analysis is incomplete. Movements across the head are generally curved [3-13, 3-14].

The confusion that exists between the perspective of a straight axis and the arched structural relationship of certain forms can be easily clarified by noting the connection between the archer's crossbow and its string. This string and bow principle is particularly useful in understanding the curved perspectives that occur across the face [3-14]. In the archer's bow, both string and bow have common points of origin. It is the "straight string" axis that may be held in mind and left unstated, while the bow (archlike) curve of the lips or the curvature through the eyes is projected in a related perspective sequence across the face [3-15].



3-14

3-13
Foreshortened Skull (lithograph), from Anatomie de L'Homme by Jules Cloquet. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

Curved directions and opposing planes are easily seen in this foreshortened view of the skull. Note the angles of the jaw, the arches of the teeth, and the curve through the cheekbones, eye cavities, and forehead. These curves are important in drawing the features. Observe their influence in illustrations 3-14, 3-15, and 3-16.

3-14
Sketch of Girl's Head, Looking Up by the author. (Photograph by Kalman Zabarsky.)

This study can profitably be compared with the Cloquet skull [3-13]. Curves through the features are clearly dependent on the underlying skull structure. Related axes may be conceived on the principle of an archer's bow and string. (This principle is seen in the foreshortened full figure by Mantegna [1-4].)

This same principle should be noted in detailing smaller relationships along the vertical median axis of the head [3-16]. This vertical axis has to be identified through the sequence of steplike, sharply opposed angles that make up the profile. These planes are foreshortened in a three-quarter view [3-17, 3-18] of the head.

Additional bone and muscle relationships are important to the form of the head. The zygomatic arch, a process of the temporal bone, behind the cheekbone is a clear and obvious organic limit between the temple plane and the plane enclosed by the angle of the jaw (masseter muscle). Auxiliary muscles fill out the plane beneath the eye cavity and are enclosed by the zygomaticus major muscle and the nose. A number of small muscles activate various facial expressions (frowns, smiles, etc.) [3-19].

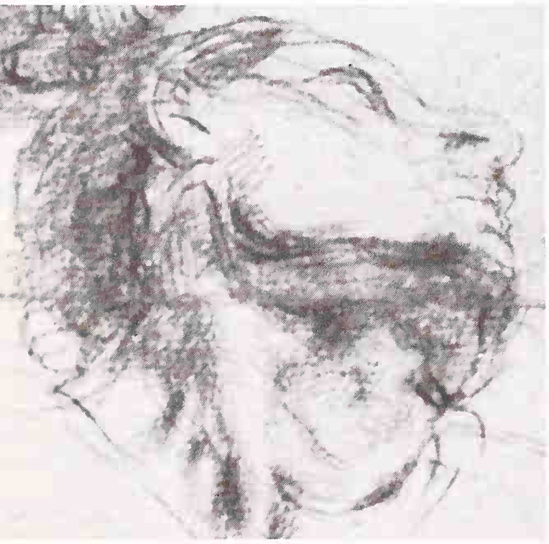
3-15
Head of the Emperor Vitellius (charcoal and white chalk) by Tintoretto. (Courtesy: The Pierpont, Morgan Library.)

The two previous plates may be viewed as an introductory analysis to arched movements through the face, seen here in the musculature of the eyes and around the mouth (orbicularis oris). Observe the strong marking-out of vertical guidelines from both jaws to the temple plane and the converging limits of the almost peaked, foreshortened forehead.

3-16
Detail from Vari Studi di Figura (chalk), Scuola Emiliana. (Biblioteca Reale, Turin.)

An extreme view looking up and under the head. The bony, arched structure of the jaw is stressed. The curve of the foreshortened eye describes the bulge of the round eyeball beneath. Structural divisions in the planes of the face are lightly drawn from the chin through the corner of the mouth into the cheekbone. The side of the face resembles a slightly distorted diamond-shaped plane.

3-16



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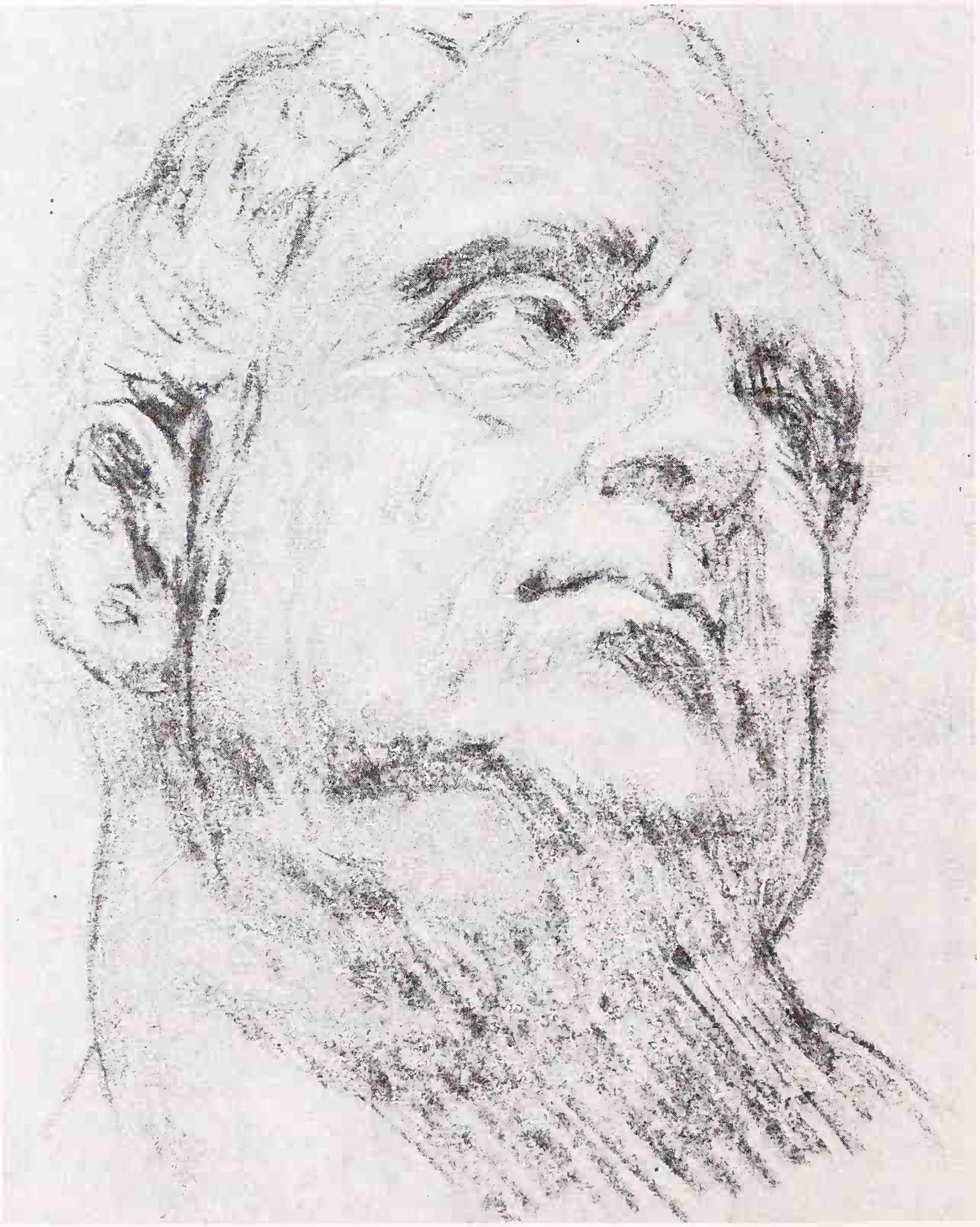
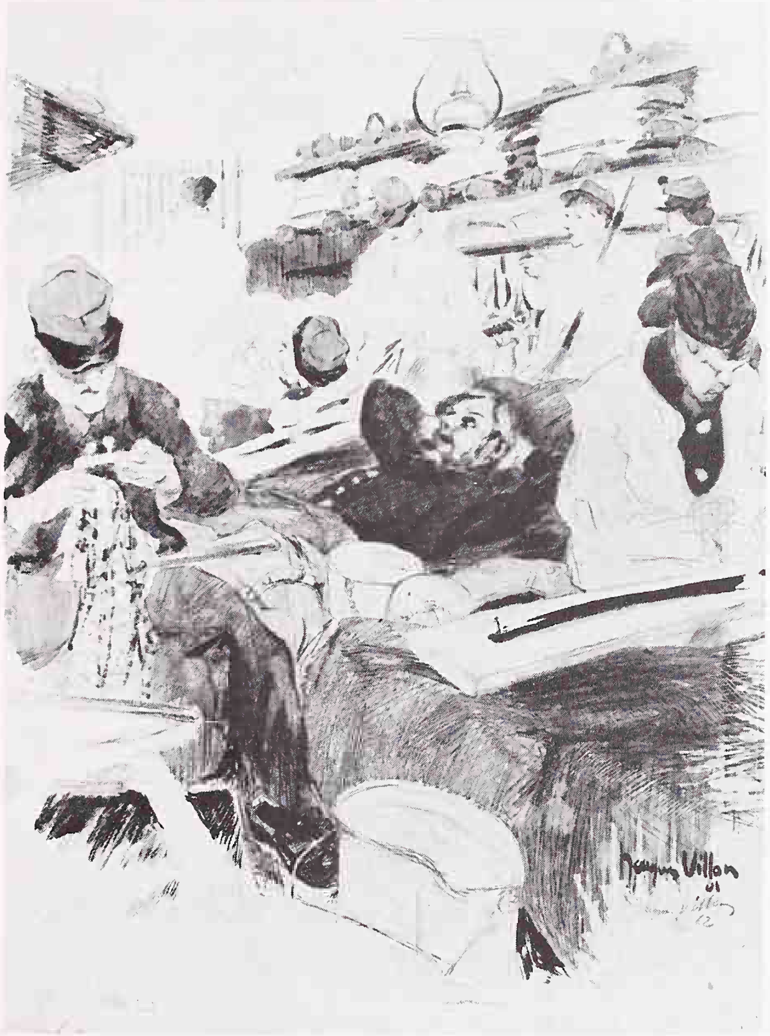
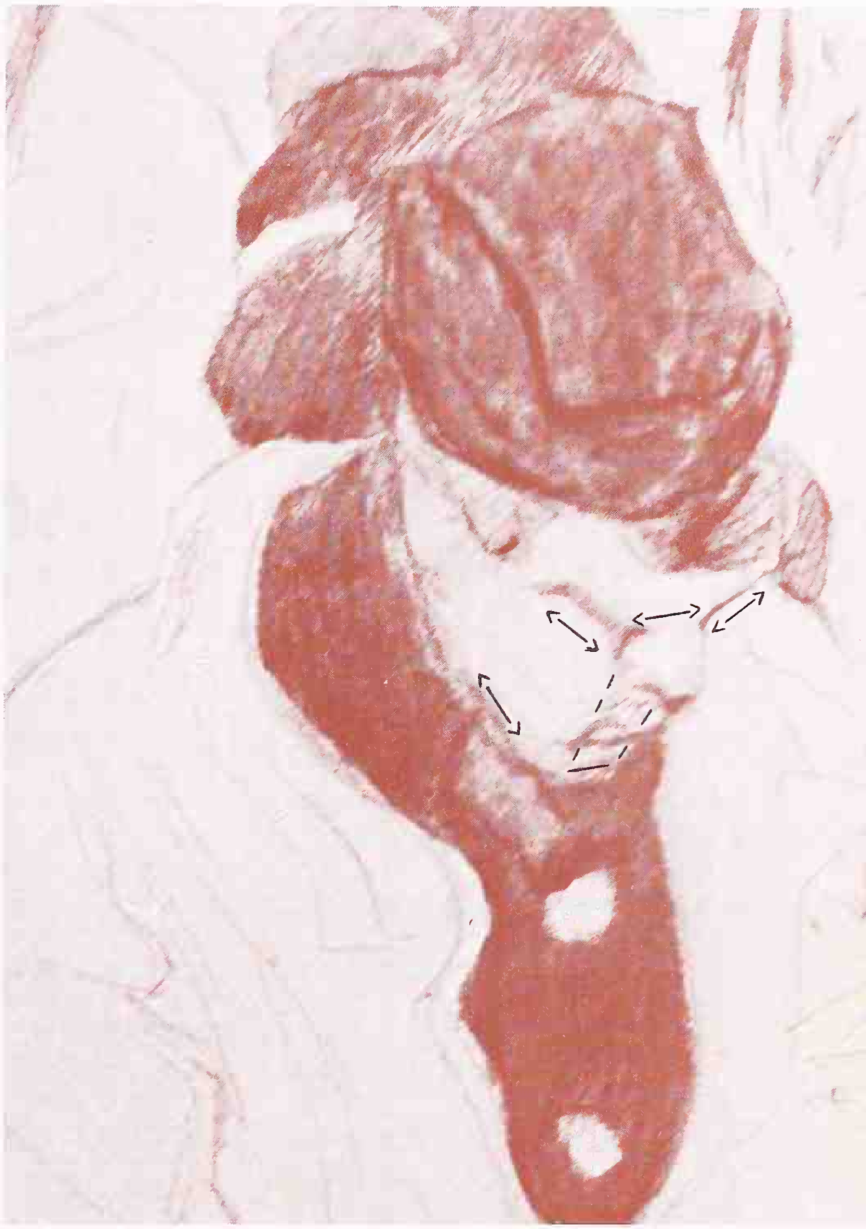




3-17

3-17
How Sweet It Is To Do Nothing (mixed media) by Jacques Villon. (R.M. Light and Company, Inc., Boston. Photography by Kalman Zabarsky.)

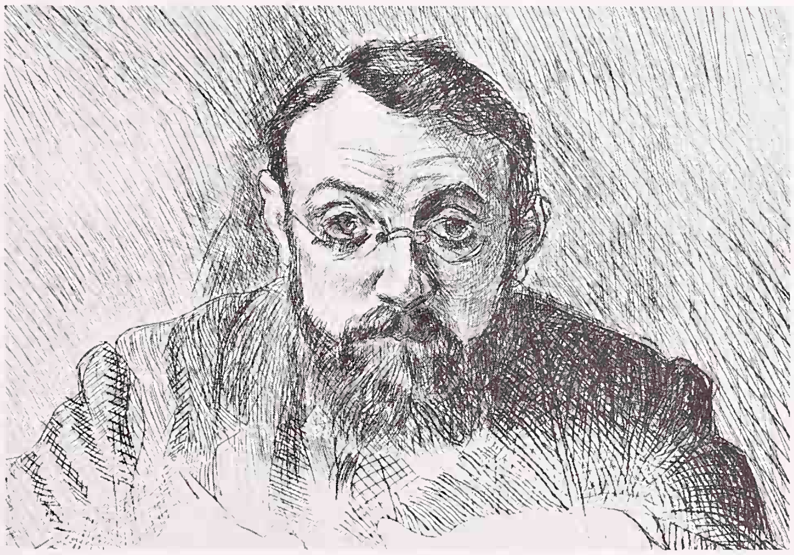


3-18

3-18
Detail from How Sweet It Is To Do Nothing by Jacques Villon.

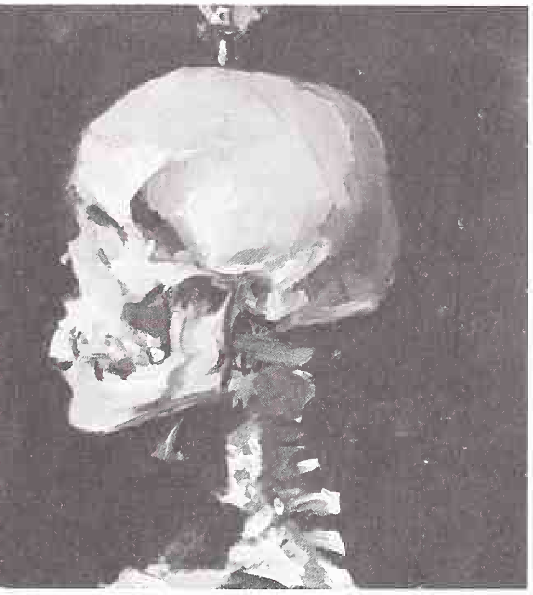
This detail is of the head and shoulders of the figure in the far-right foreground. When the head is bent forward, the curved perspective and axes across the skull are still influential and not to be overlooked.

3-19



3-19
Detail from Self-Portrait (etching) by Henri Matisse. (Fogg Art Museum, Harvard University; Gift of Norbert Schimmel.)

Matisse, in this early, intense, carefully observed self-portrait, demonstrates clearly the angular change of direction in the cheekbone, showing the sharply compressed, foreshortened zygomatic arch moving to the ear away from the front plane of the face. The angles from front to side are clear.



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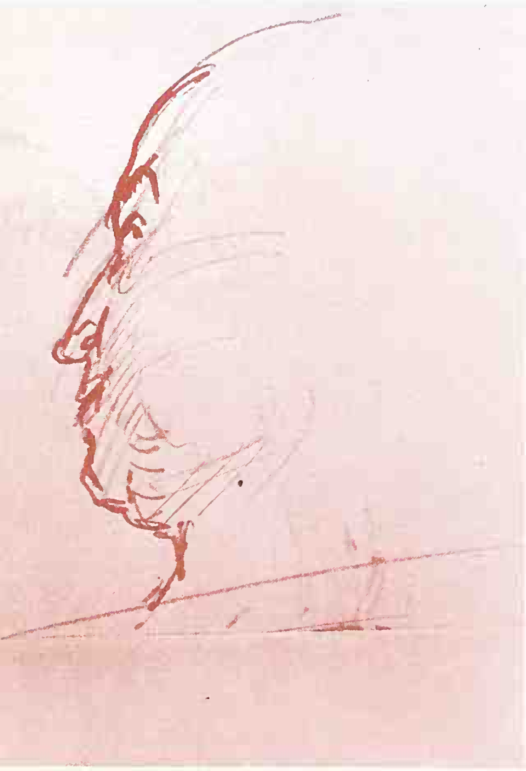
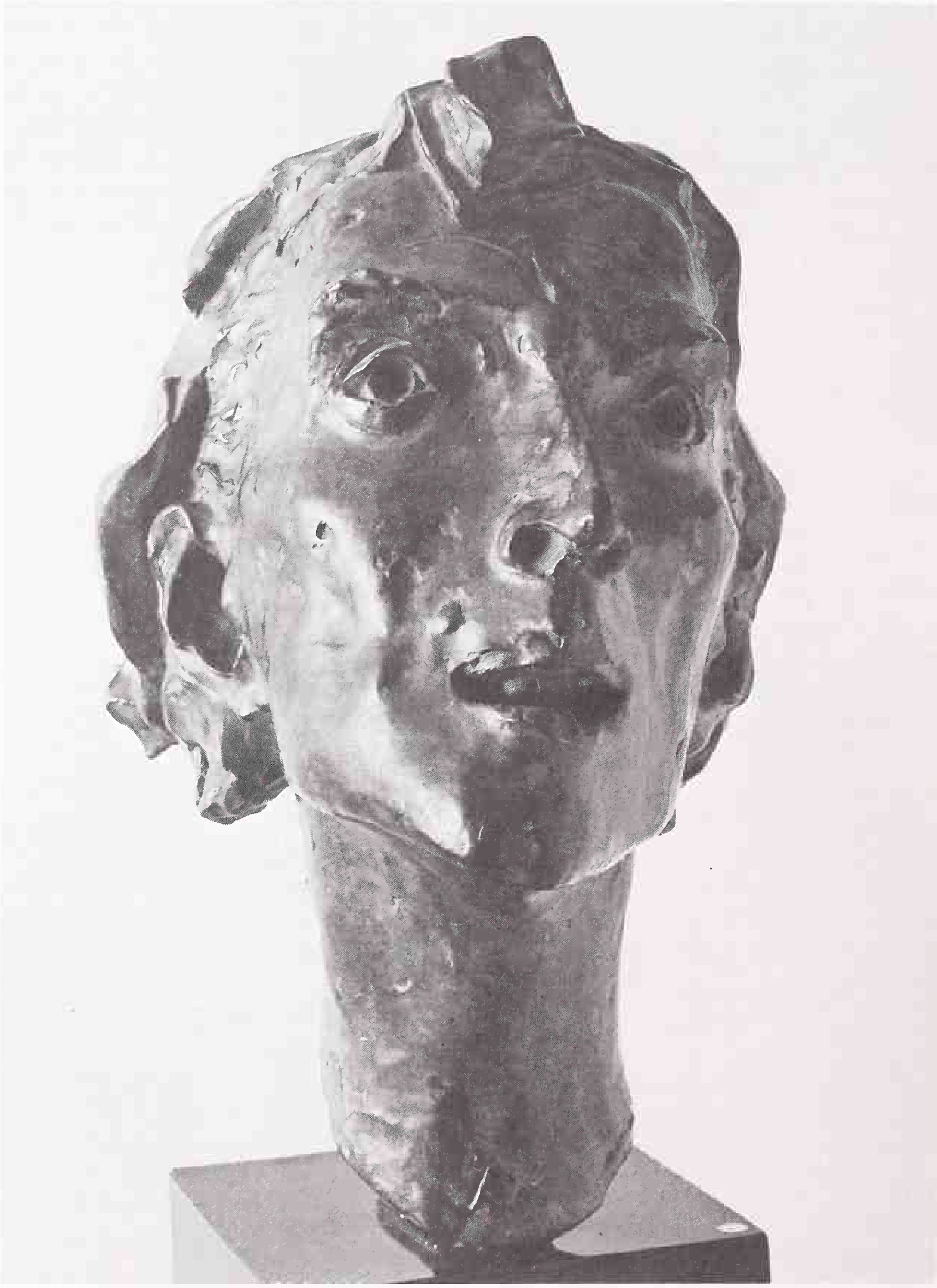


3-21



3-22

3-20
Skull (oil on canvas, 1979) by Larry R. Collins. (Collection: Thomas Conomacos, New York. Photograph by D. James Dee.)

Foreshortening in the profile view is deceptive. Close, subtle compression of the front planes of the face in profile is difficult to identify. The mouth, eye, and orbit are reduced by half. Drawn too wide, foreshortened planes compete with the side planes (i.e., planes parallel to the picture plane.) The relationship between front and side planes in the skull determine the foreshortening.

3-21
Foreshortened Profile (pencil) by the author. (Photograph by Iso Papo.)

Sharply turned planes in foreshortened view of the features. Foreshortened planes in the profile view are often drawn too wide.

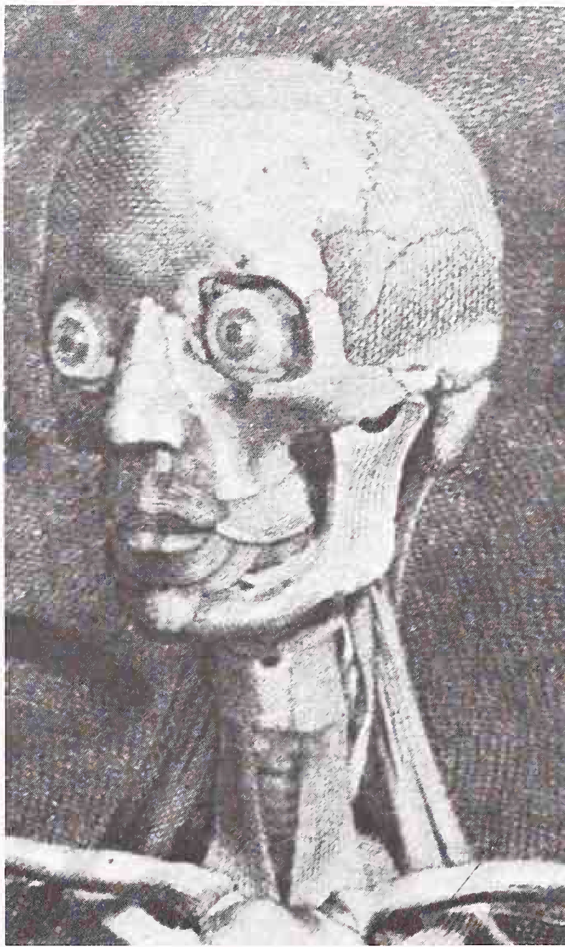
3-22
The Student (bronze) by David Aronson. (Courtesy: Pucker/Safrai Gallery, Boston. Photograph by George Vasquez.)

Aronson's bronze head exhibits a synthesis of skeletal angularity at the jaw and cheek and intense mobility in the muscles around the mouth. The muscles of facial expression demonstrate their function in the context of expressive form.

THE EYE

The eye has a wide range of very subtle movements. These remarks on the eye are suggestive rather than exhaustive but represent important observations in drawing, once the overall direction and axial curve of the eye are set.

The eyeball [3-23] is not quite a perfect sphere. The added fullness of the iris alters the curvature of the lids in its movement from side to side. The upper lid projects forward over the eyeball—the lower lid moves backward and is generally set deeper in the cavity [3-24]. The lids join into the elliptical orbicularis oculi muscle enclosing the eyeball in the socket [3-25]. In general, along the vertical dimension of the eye the iris is set on a diagonal axis [3-26].

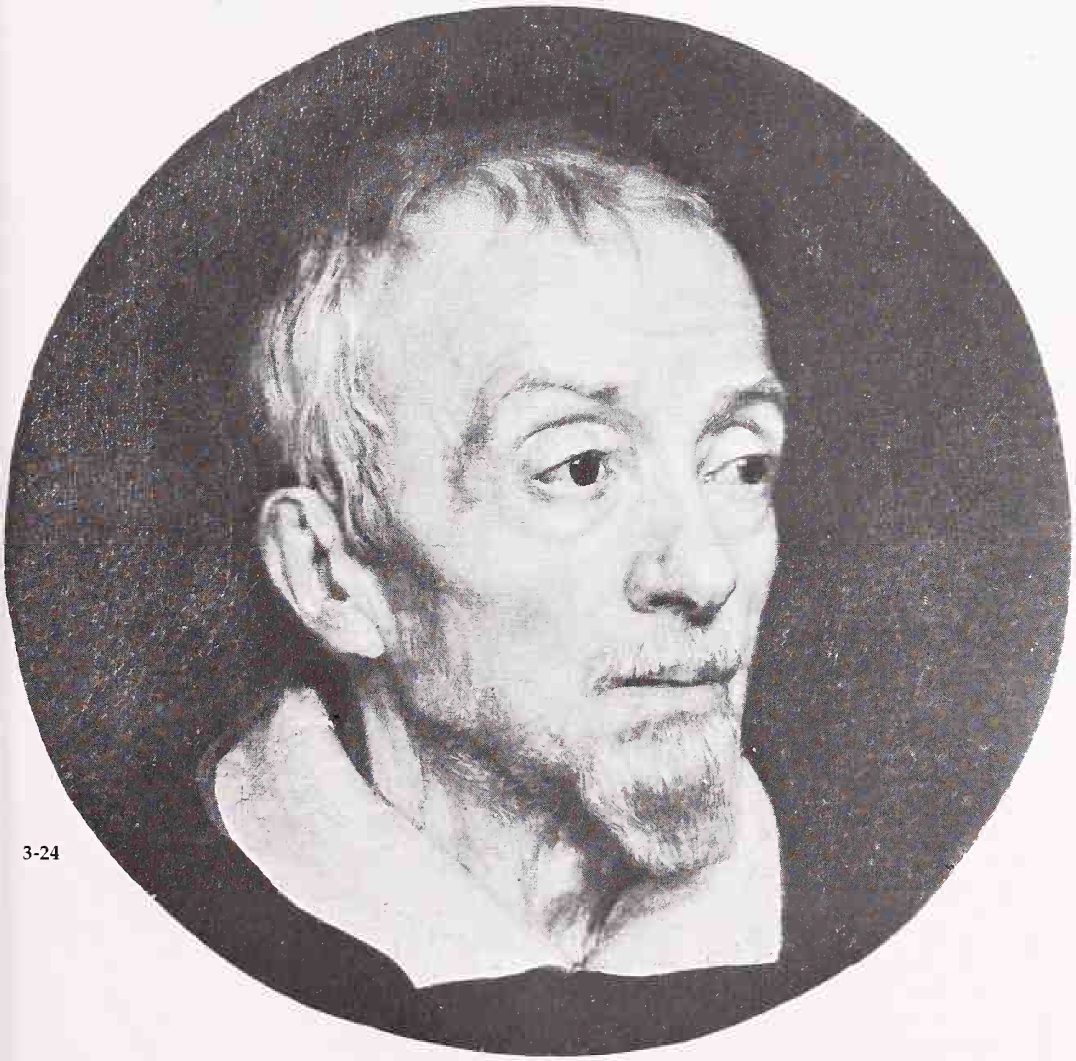


3-23

3-23

Skull with Eyeball (engraving), from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The eye is a spherical volume within the eye cavity. The upper and lower eyelids are curved planes of a distinct thickness, draped over this round form. (See the delineation of the eyelids in illustration 3-24). In this engraving, note the formation of the orbicularis oris muscle enclosing the lid structure.



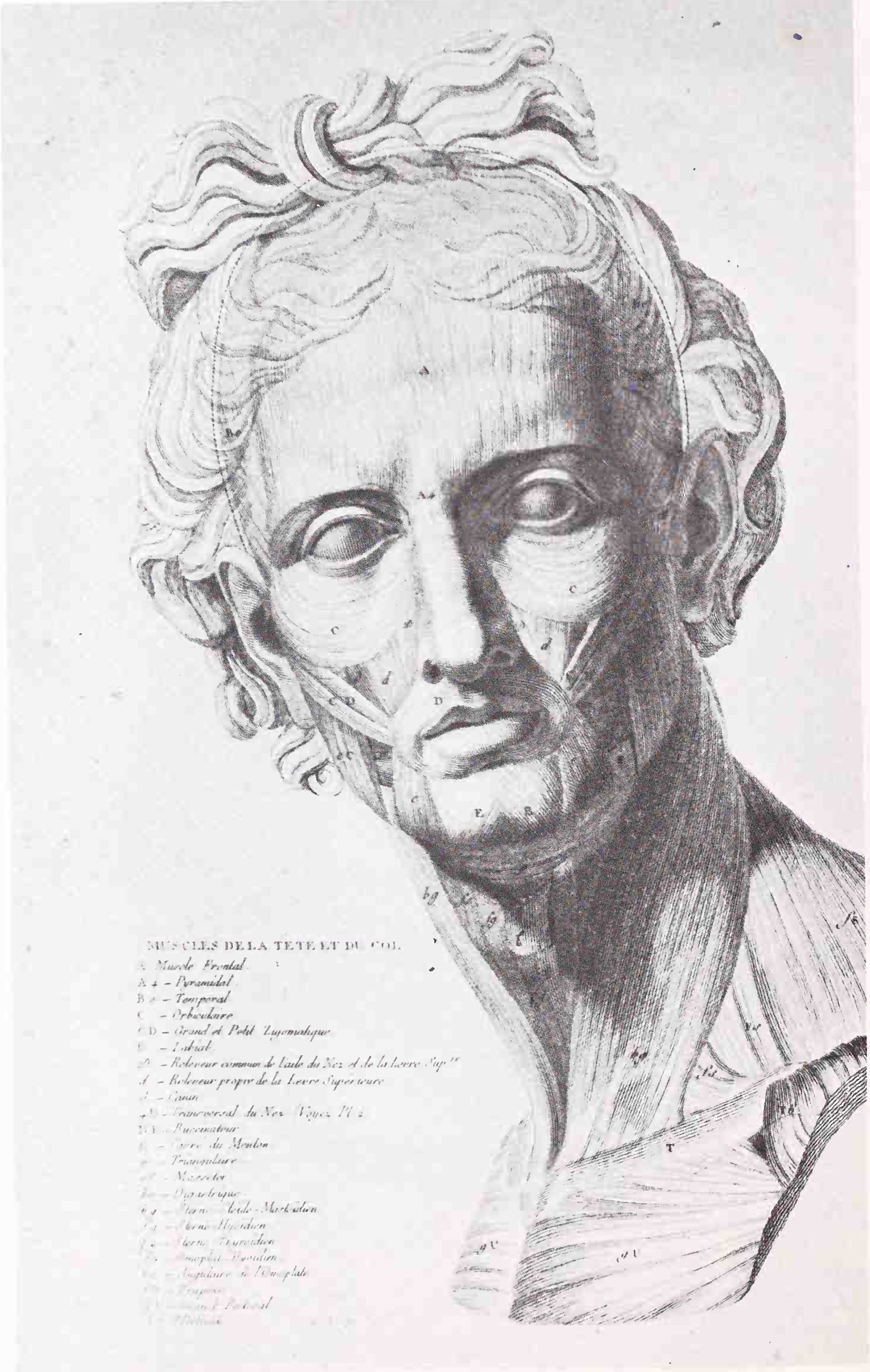
3-24

3-24

Portrait of Guido Reni by Simone Cantarini. (Pinacoteca Nazionale, Bologna.)

In this portrait by Cantarini, the tense, sensitive, and distinct features of the painter Guido Reni are acutely observed. The eyelids follow the form of the eyeball, clearly reflecting its spherical volume. Skeletal structure at the cheek and jaw is revealed beneath tightly strained skin and muscle.

3-25


MUSCLES DE LA TÊTE ET DU COL.
A. Muscle Frontal.
A 4 – Pyramidal.
B 2 – Temporal
C – Orbiculaire
C D – Grand et Petit Zygomatique
D – Labial.
– Releveur commun de l'aile du Nez et de la Levre Sup.re
d – Releveur propre de la Levre Superieure
– Canin
– Transversal du Nez Voyez Pl 2
– Buccinateur
– Carré du Menton
– Triangulaire
– Masseter
– Digastrique.
– Sterno-Cleido-Mastoïdien
– Sterno-Hyoïdien
– Sterno-Thyroïdien
– Omoplat-Hyoïdien
– Angulaire de l'Omoplate
– Trapeze
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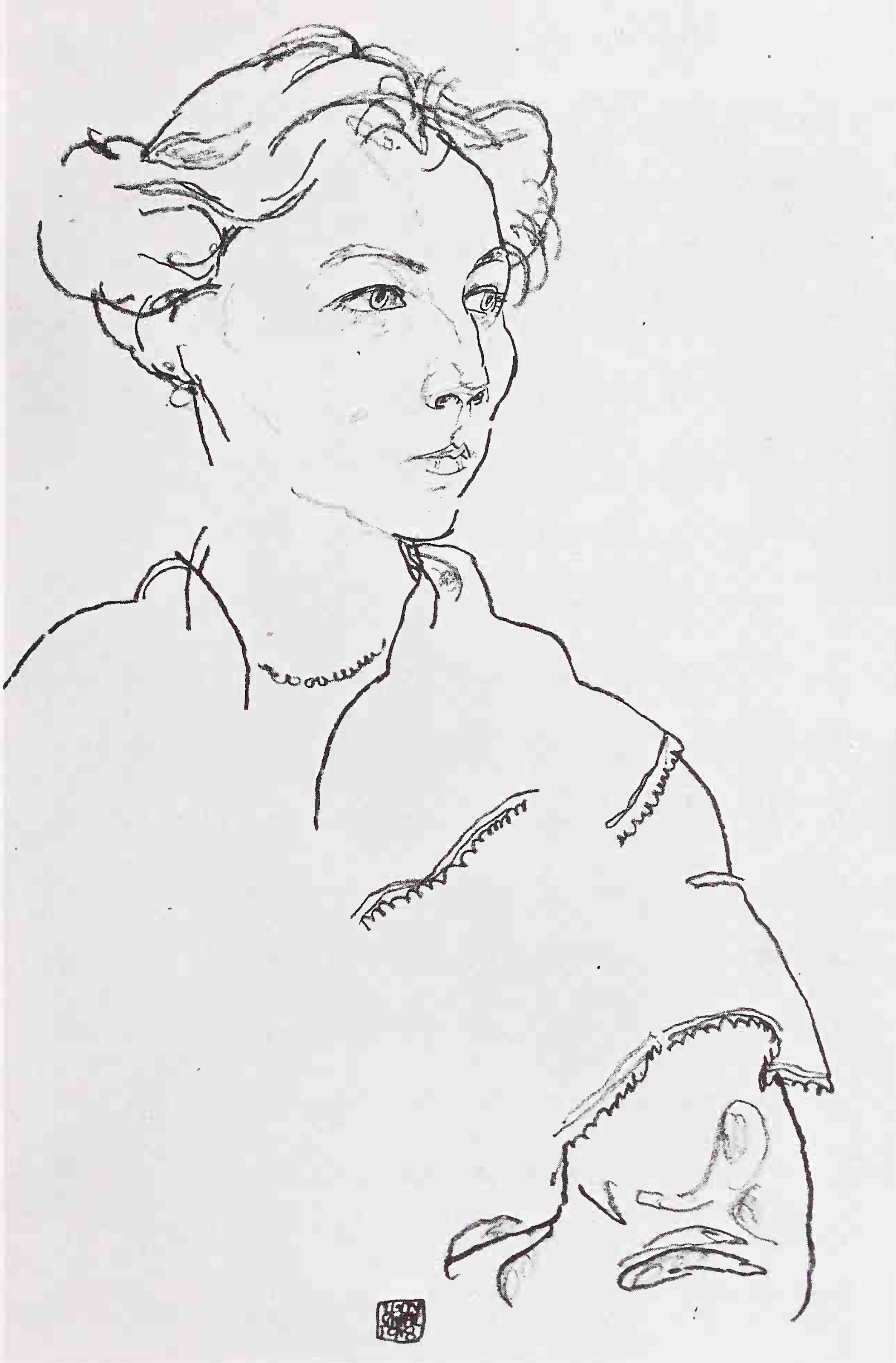


3-26

3-26

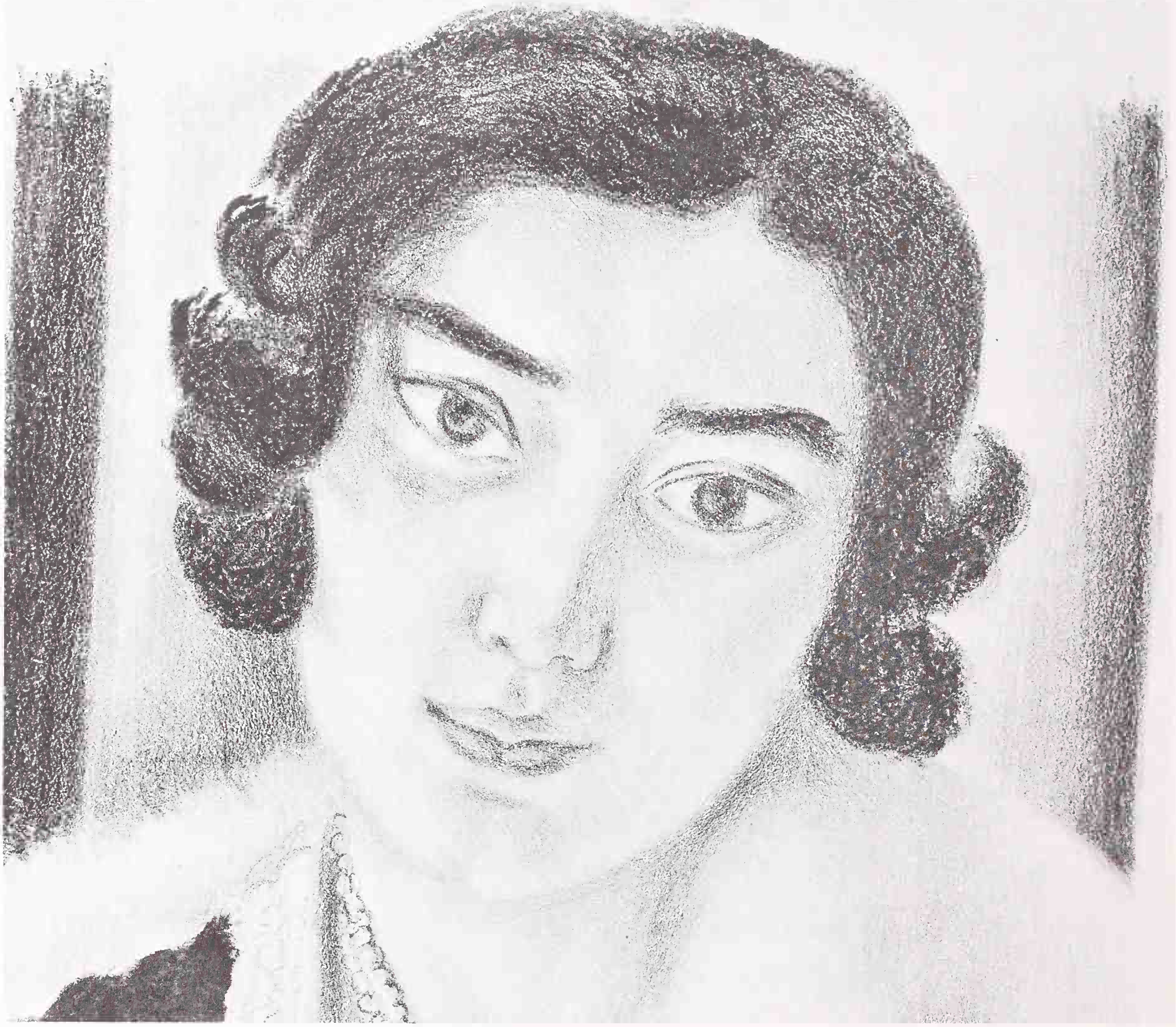
Portrait of a Woman **(charcoal) by Egon Schiele. (The Dial Collection. On loan to the Worcester Art Museum.)**

In this portrait, the structure of the eyes, the nose, and the foreshortening of the far side of the lips have been clearly observed and economically delineated. Note the downward, diagonal axis of the pupil of the eye.

3-25

Muscles of the Head, from Anatomy of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The eyelids have solidity and thickness and follow the curved volume of the spherical eyeball. Compare the eye in this diagram drawing with the eyes in the Matisse lithograph [3-27], the Cantarini portrait [3-24], and the Schiele head [3-26].



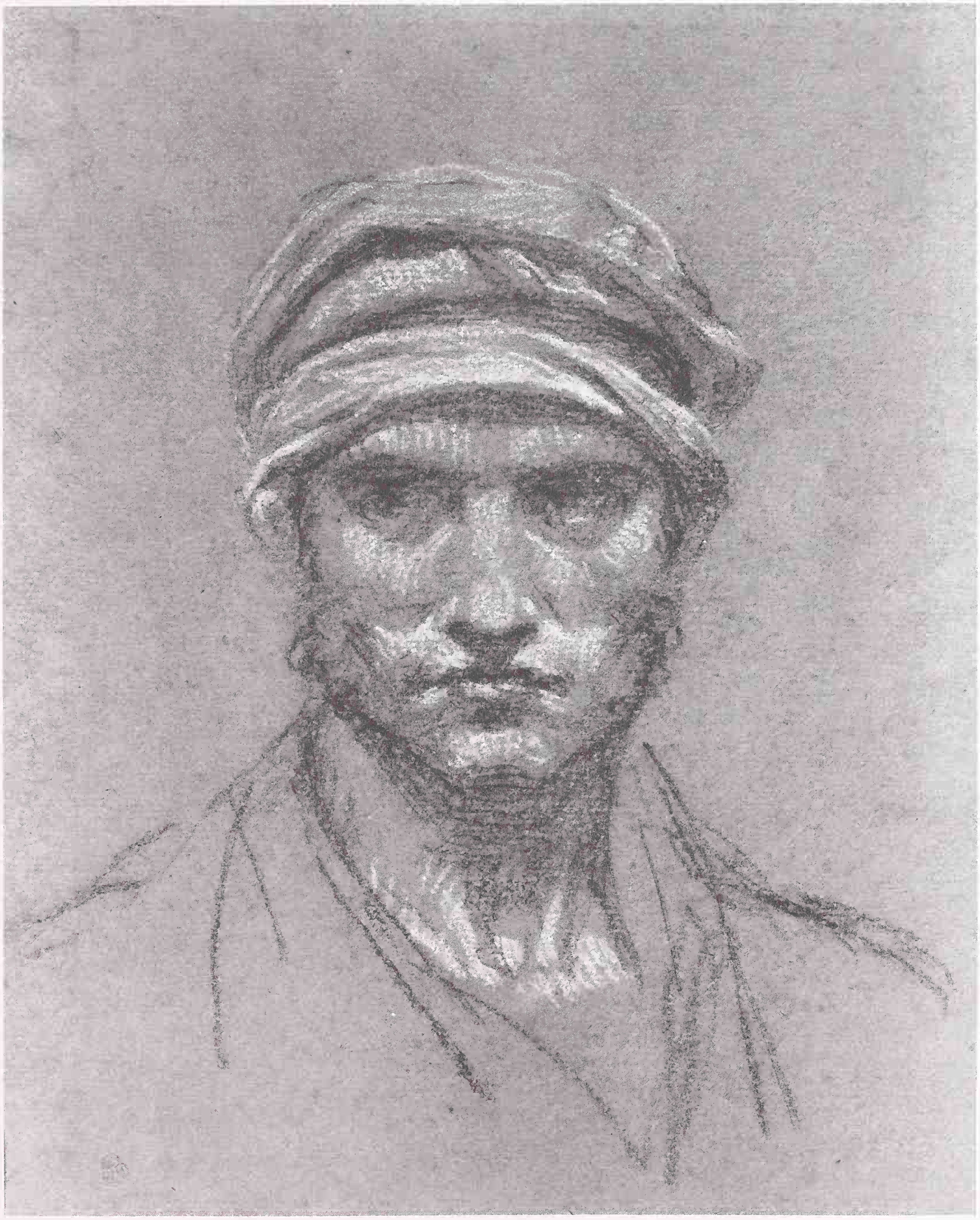
3-27

3-27

Detail from The White Boa (lithograph) by Henri Matisse. (Fogg Art Museum, Harvard University; Hyatt Fund.)

Below the lower lid of the left eye, three clearly defined planes follow the form of the eyeball. In this lithograph the enclosing planes of the cheeks have also been closely studied in relation to the eyeball.

It is most important, in drawing the eye, not to limit one's observations to the "linear" opening of the lids. To establish convincingly the position of the eye, surfaces surrounding the eyelids should be carefully studied [3-27]. The eye cavity presents clues on the outer skin surface that are helpful in locating the eye form. The structure of bone beneath the eyebrow, the orbital process and depressions just above the cheekbone (malar) and below the lower lid, the temple plane and the process beside the nasal bone may be noted as an enclosing frame for the eye [3-28]. The inner tear duct of the eye is frequently misplaced forward on the nasal bone. This projects the eye out of the cavity. A considerable plane exists deep on each side of the bridge of the nose, and noting its dimension will keep the eye in its place, behind the forehead plane. This inner surface of the eye cavity is the nasal process of the maxilla bone.

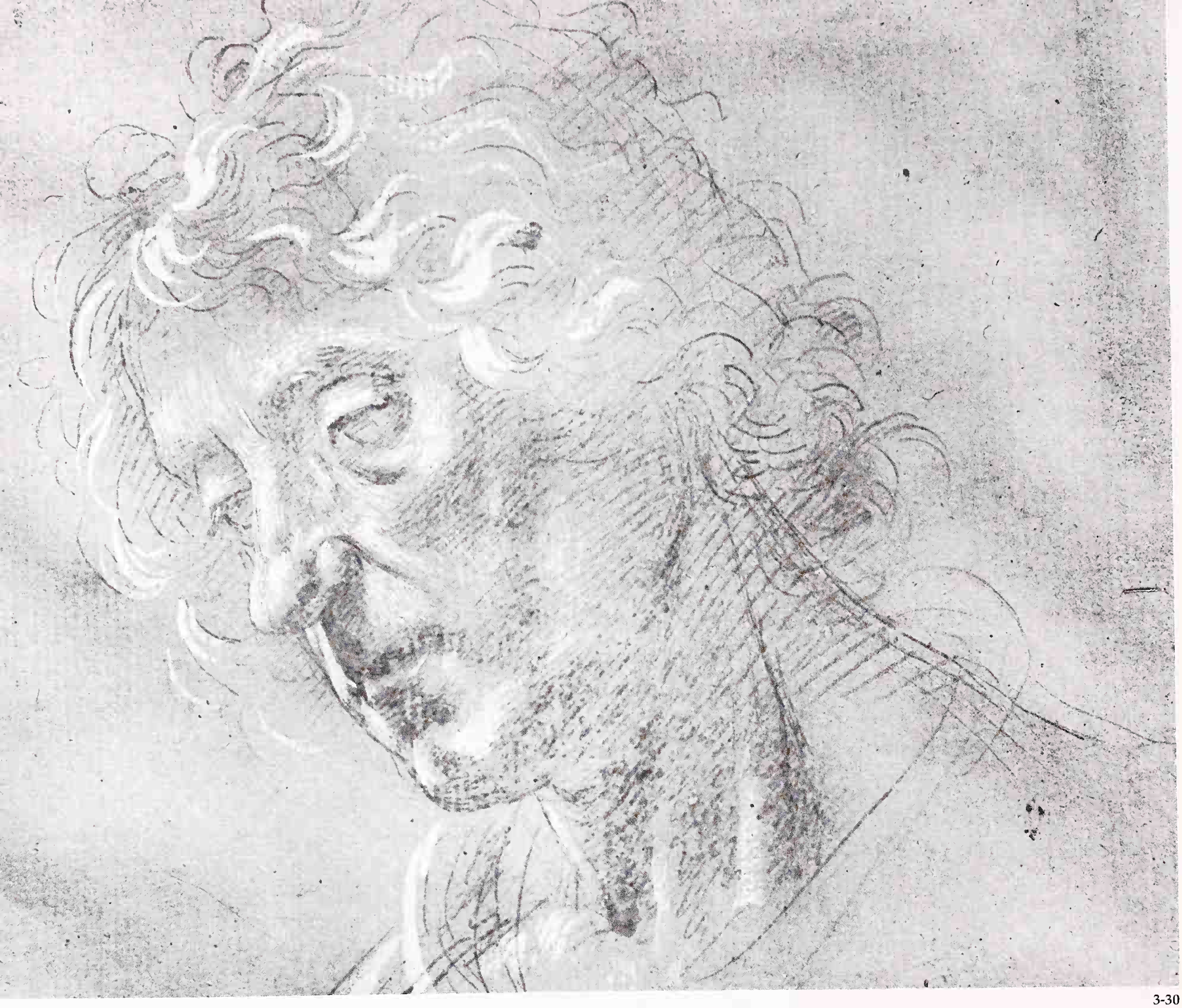


3-28

3-28

Portrait Head of a Man, (black and white chalk on blue paper) by Pierre Paul Prud'hon. (Museum of Art, Rhode Island School of Design, Providence.)

Drawing on toned paper provides a unifying middle value on which planes of light and planes of dark may be developed. The dark, diamond-shaped eye cavities have been framed by planes of light on the forehead and cheekbones. Prud'hon, by the use of white chalk, has focused attention on the larger planes of light as a firm context for the eyes, nose and mouth. This suggests a useful exercise to avoid rendering the features as separate, flat decorative entities. The student should attempt a self-portrait, using light and dark chalk on toned paper to describe only the large planes of the head, leaving the features out. This will provide a proper context into which the features may be more effectively integrated in the final stages of the drawing.



3-30

3-29
Cartilage of the Nose, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

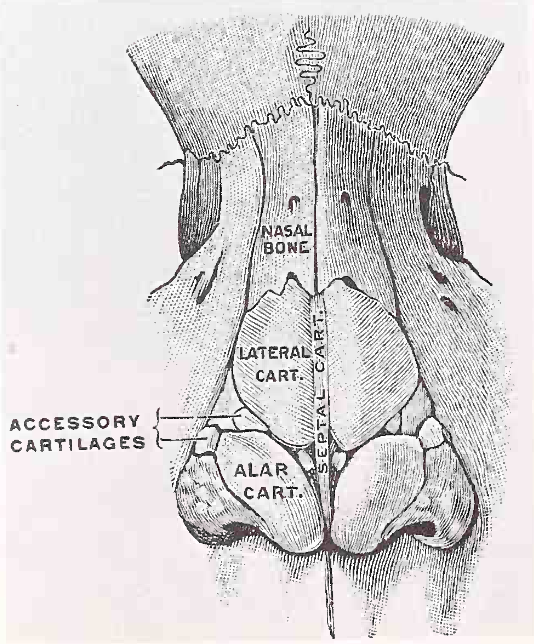
The juncture of bone and cartilage may easily be located by pressing the fingers along the nasal bone to the juncture with flexible cartilage.

3-30
Head of a Man (metalpoint on toned paper, heightened with white) by Filippino Lippi. (Windsor Collection. Copyright reserved.)

The cartilage structure of the lower end of the nose thickens this part of the form. In order to understand the volumes and planes, it may be helpful to see this form in terms of the accompanying diagram.

3-31
Conical Analysis of the Nasal Cartilage.

This analysis is based on the detail of the nose from the portrait by Filippino Lippi. The lower alar cartilage may be likened to two conical units resting one over the other and in opposing directions.



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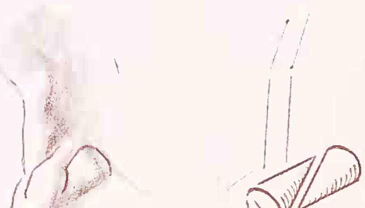


3-31

THE NOSE

The three major planes of the nose (two sides and front) are subject to wide and subtle variation, from small, compact forms to large prominences, occasionally accentuated to the point of caricature. In some individuals the forms of the nose are a small and tightly integrated unit—so much so that details to be discussed here may not seem apparent or even to exist. Close study, however, will reveal the clues to the anatomy of the nose.

It is important to understand the lower alar cartilage and its conical structure. Its relation to the lobe of the nostril may be compared to two half cones pointing in opposite directions and locked, one above the other, on each side of the nose [3-30, 3-31]. The joining of this alar cartilage at the tip of the nose is sometimes marked by a thin furrow [3-29].

The underneath planes that contain the nostrils are obscured by the nostril opening. The dividing septum forms a center horizontal plane between two slightly angled directions. The nostrils lie within these planes, rising diagonally on either side [3-32, 3-33]. To achieve a convincing projection of this form, it is important to observe the surface just outside the nostril opening. This is clearly illustrated in the Gris drawing.

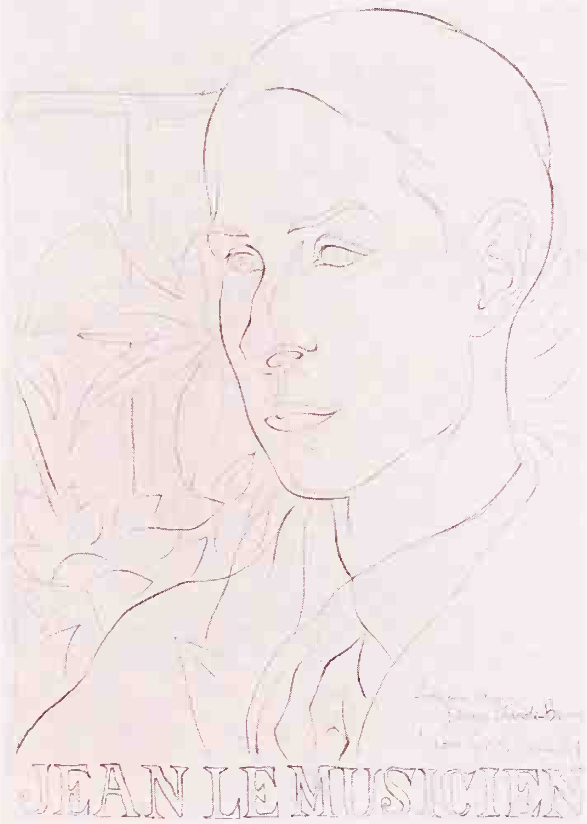
Schematically, the planes seen from the front are three in number. The attachment of the septum and lobes of the nostrils on the head can be observed dimensionally in the profile. The lobes extend into the face, within the profile contour. The septum is shorter, and from a front or three-quarter view this relationship should not be ignored, or the nose may appear false, like a party mask, with no attachment onto the head. The nose fits the curvature of the maxilla bone above the archlike turn of the teeth (and the curve of the orbicularis oris muscle).

3-32
Jean, le Musicien (pencil) by Juan Gris. (Private collection, Boston. Photography by Kalman Zabarsky.)

The planes of the nose are clearly explained in this line drawing.

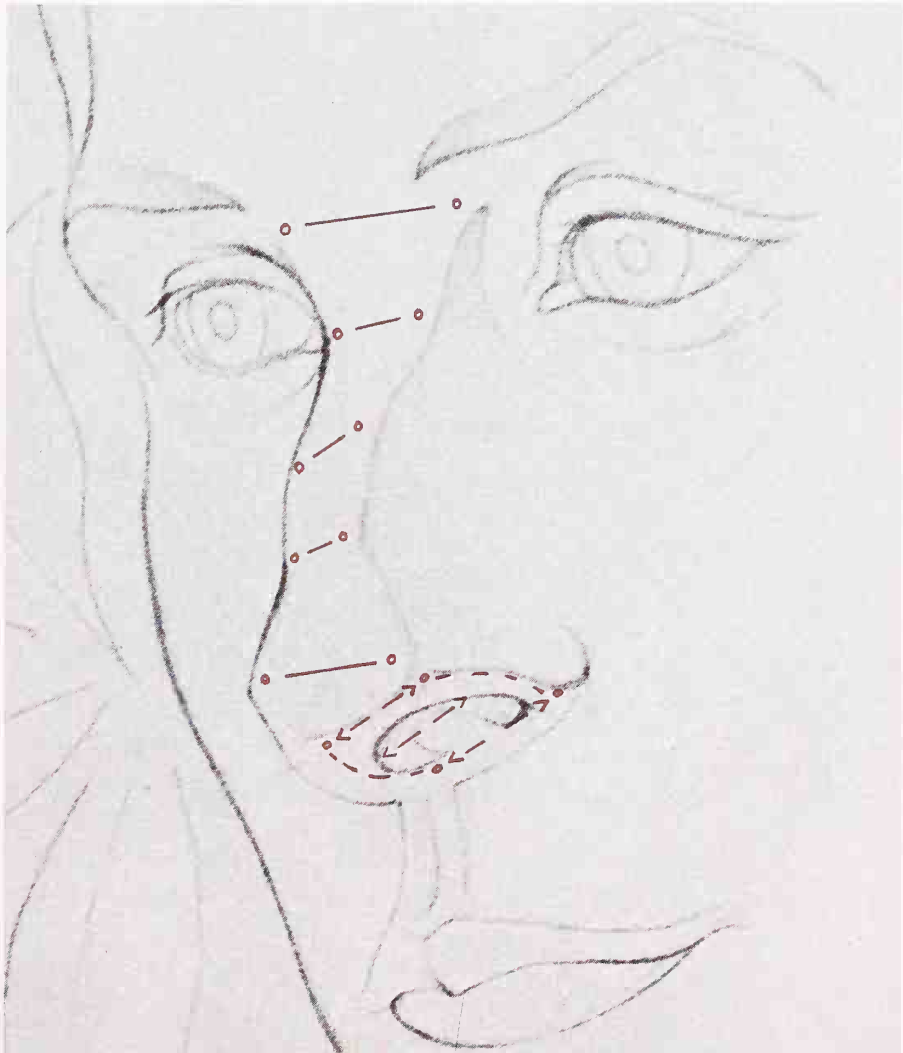
3-33
Detail from Jean, Le Musicien by Juan Gris.

The projecting underplanes of the nose are clearly defined. The opening of the nostril is contained within a larger, enclosing diagonal plane (note arrow analysis). The front planes from the bridge of the nose are implied by a sequence of related angular changes in the two enclosing contours.



3-32

3-33



3-34
Profile Head: Deeper Muscles, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

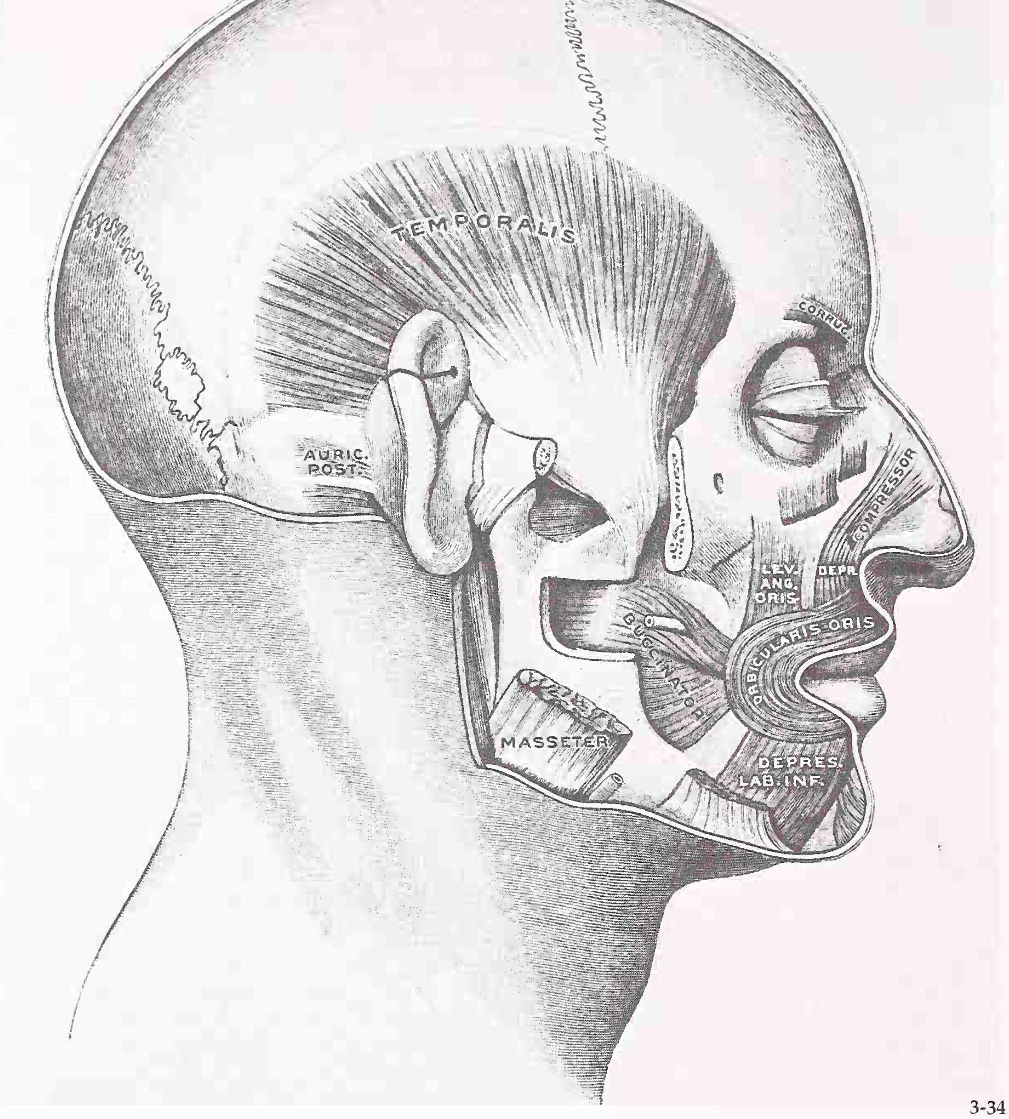
The removal of the zygomatic arch exposes the insertion of the temporalis muscle into the coronoid process of the mandible. The attachment (origin) of the buccinator muscle is shown in the cutaway portion of the ramus of the mandible.

3-35
Skull, from Anatomie of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The vertical perspective of the lips should be carefully noted. The steplike sequence of planes from the philtrum to the upper lip, and lower lip may be obscured by the emphatic horizontal curves. The opposing axes are shown in the diagram.

3-36
Diagram of the Lips.

The lips have a strong symbolic identity and are often described in drawing as isolated flat decorative shapes. The lips should be seen in the context of adjacent planes. They are influenced by the curve of the teeth, and join with the planes of the orbicularis oris muscle, above and below.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CORRUG.
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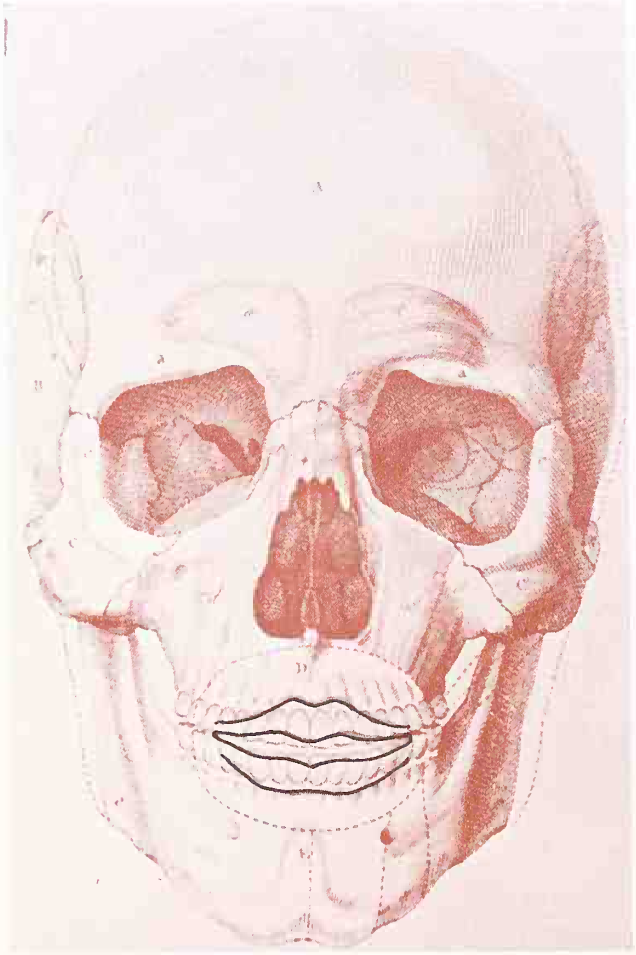
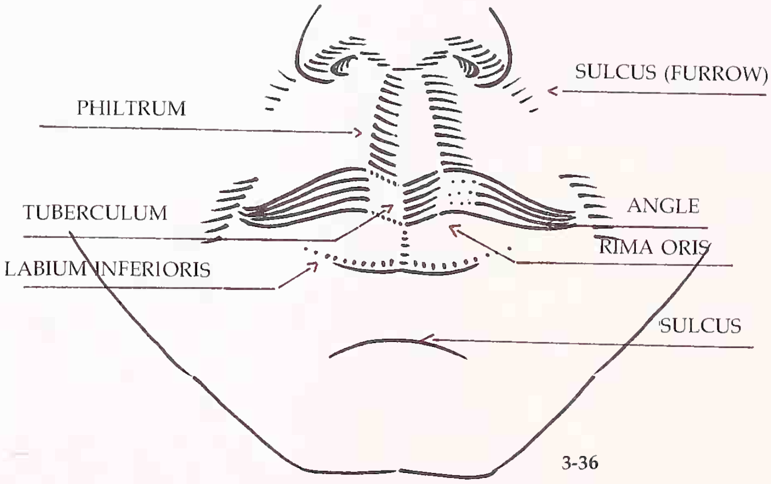
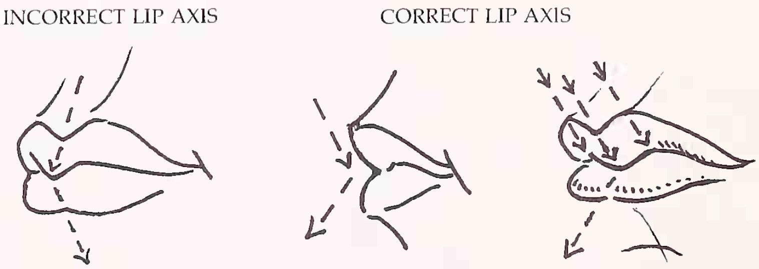
3-34




SULCUS (FURROW)
PHILTRUM
TUBERCULUM
ANGLE
RIMA ORIS
LABIUM INFERIORIS
SULCUS

3-36

3-35


INCORRECT LIP AXIS
CORRECT LIP AXIS

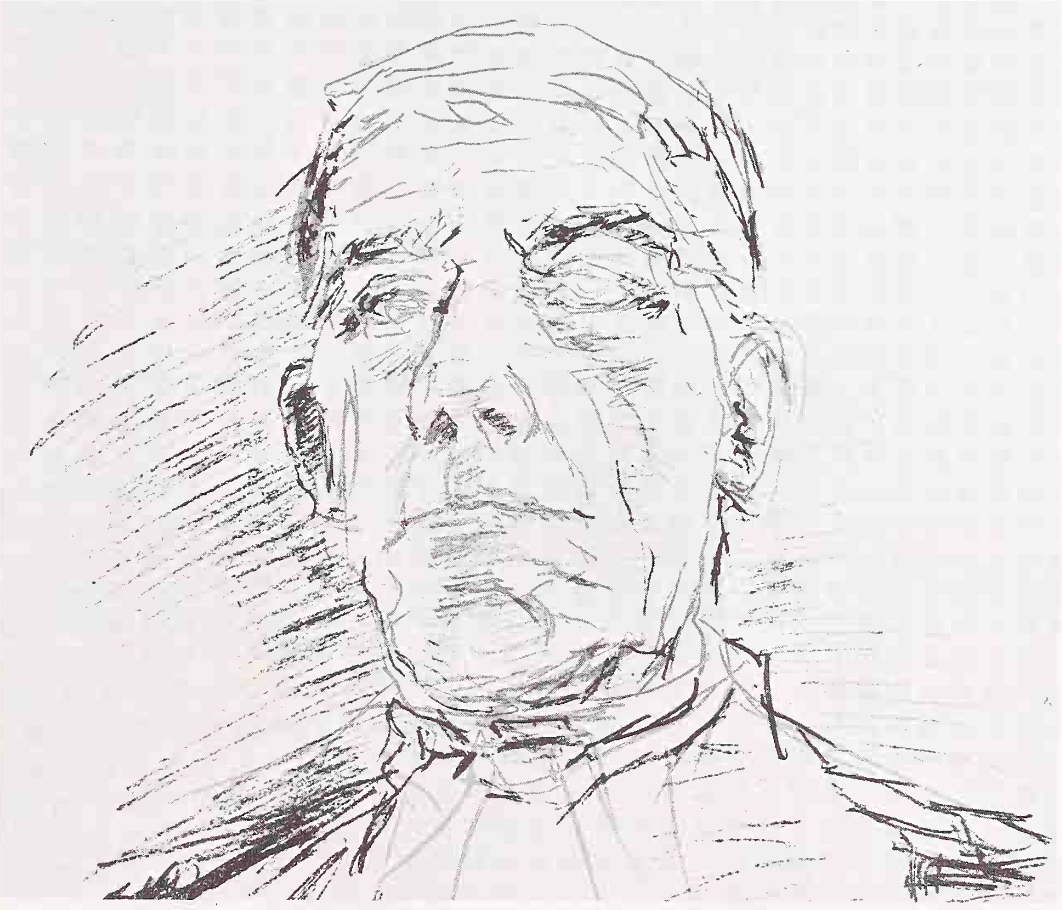
THE MOUTH AND LIPS

The arch structure of the teeth influences the curve of the lips and the fullness of the muscle surrounding the lips (orbicularis oris) [3-34]. In an eye-level, three-quarter view of the head, this arched curve causes a sharp foreshortening of the far side of the lips.

The curvature can be seen easily in a view from below, and this curve can be held consistent with the general axis of the head by noting related axes in the eyes, cheeks, and chin [3-14]. The bow-and-string principle is applicable here. The axis of the lips from one end to the other may be structured on a straight line, within the mouth, like a horse's bridle bit. The lip departs from this axis into an arch following the form of the teeth [3-34].

In drawing the refinements of lip form, the steplike opposition between the upper and lower lip and their curved perspective are important (see illustrations 3-34 through 3-37).

The chin is a relatively simple blocklike form determined largely by the structure of the mandible and angled forward in opposition to the lower front teeth. It is padded by the mentalis, the quadratus labii inferioris, and the triangularis (see illustration 3-3).



3-37

3-37

Detail from Self-Portrait (color lithograph) by Oskar Kokoschka. (Collection: the author. Photograph by Jonathan Goell.)

The expressive broken line in this lithograph should not obscure its clearly ordered, consistent perspective and its structurally forceful spatial architecture. Observe the planes under the nose and the planes bending around the upper lip and enclosing the mouth. A notably strong spatial observation is seen in the thrust from under the lower lip, back to the angle of the jaw, and enclosing the side of the face. Scale and proportion convey powerfully the character of the artist.

THE EAR

The complicated form of the ear, if not carefully studied, may easily be distorted into a flat, linear, decorative fixture on the side of the head. Its attachment to the head, surrounding the inner ear, appears sinuously convoluted, disguising major directions and significant structural groupings [3-24].

The overall axis of its attachment is generally on a diagonal, continuing the direction of the ramus of the mandible (rear vertical jawline). To further locate the ear, its inner opening in the skull may be noted below the end of the zygomatic arch [3-39].

The ear may be separated into two not easily distinguishable units: an inner basin and a complex outer frame. Enclosing the large inner basin (concha) is the flaring curvature of complex cartilage that should be understood as lifting away from the head. From the lobe below, this outer surface forms an ever-widening curved frame as it extends upward. The variable corrugations of cartilage that compose this form may be seen in illustrations 3-24 and 3-40. Important to note are the external rim (the helix) and an inner parallel rim (the antihelix), which surrounds the concha (inner bowl). The tragus is a small projecting

3-38

The Ear, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

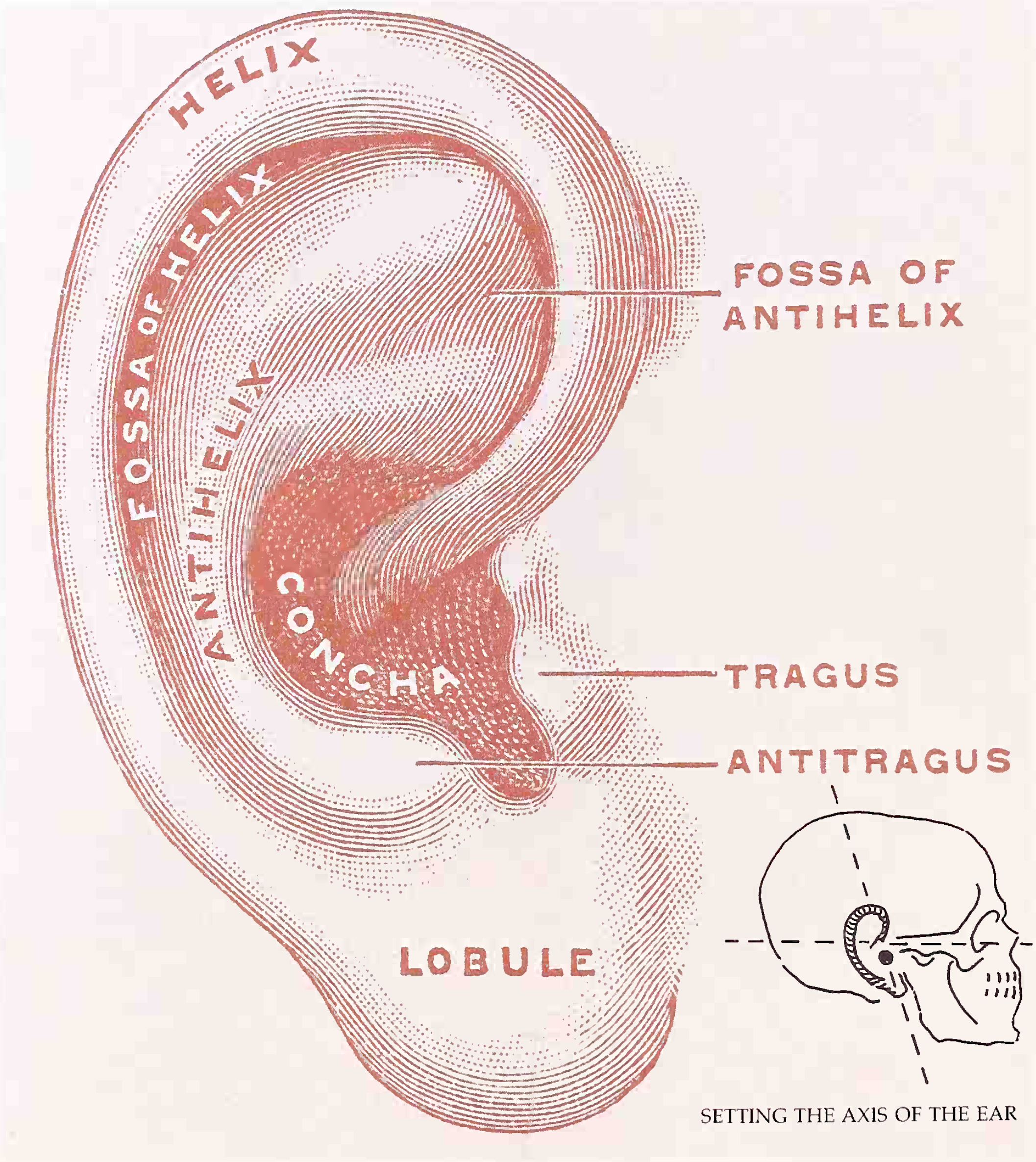
Two major units should be considered in drawing the ear: the shell-like depression appropriately named the concha and the complex outer frame composed of the antihelix and the helix. The location and axis may be established at the juncture of the zygomatic arch and rear edge of the ramus of the mandible.

3-39

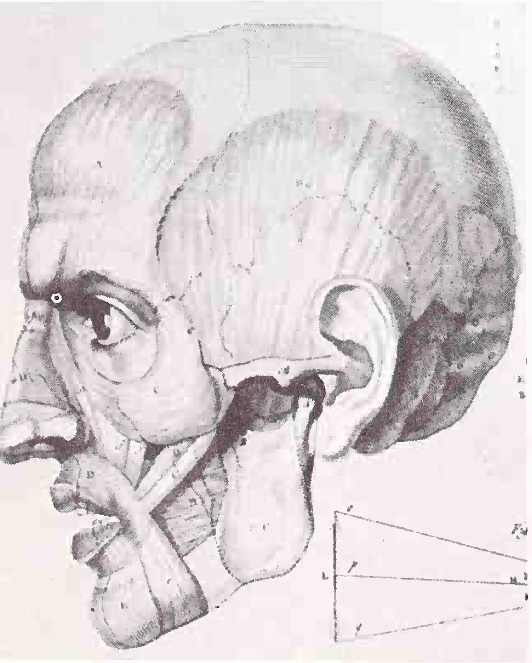
Profile: Skull and Muscles, from Anatomie of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

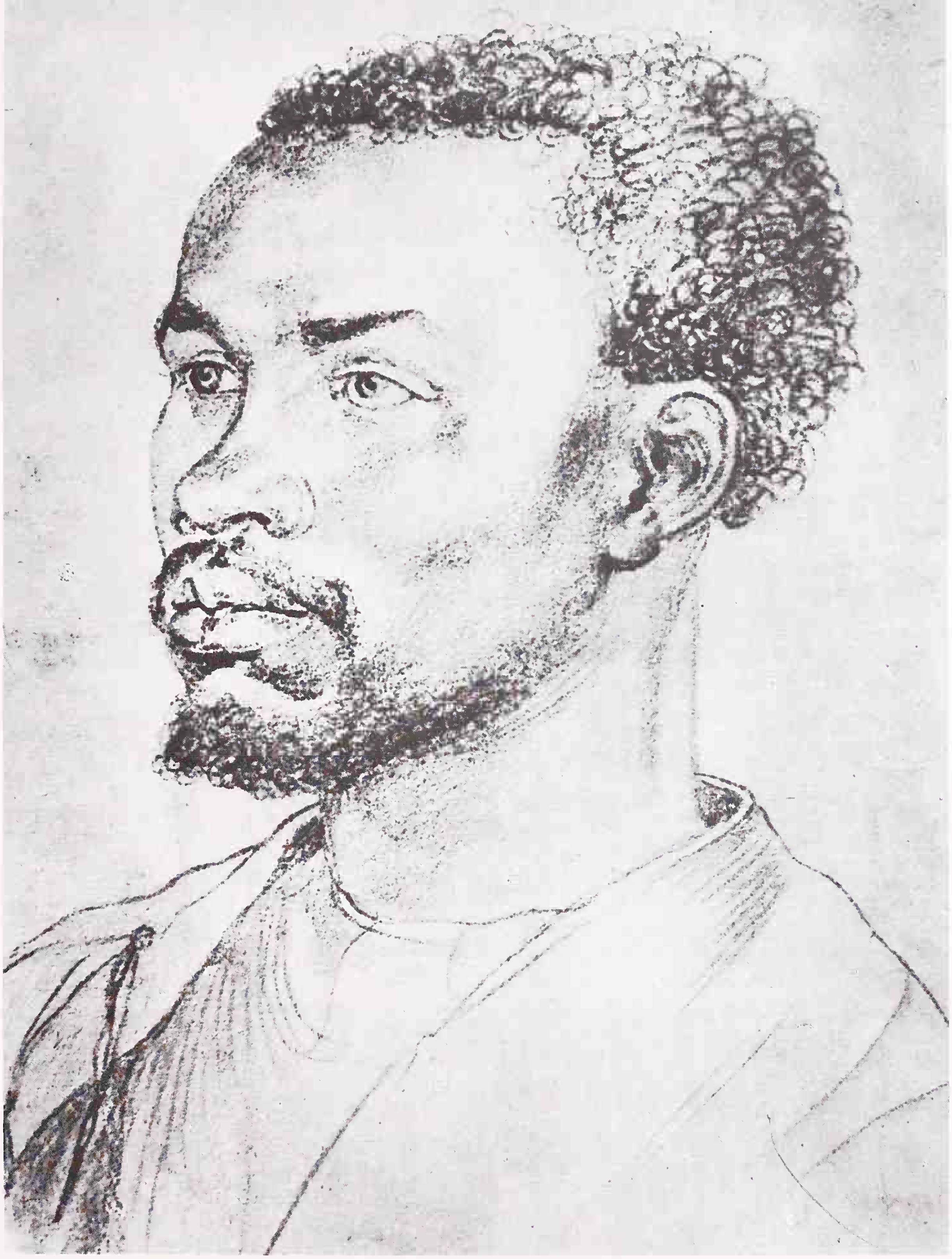
The eyes and mouth are often drawn too wide in the profile. From the side, the eye and mouth are visually reduced by one half since curvature hides the far side in foreshortening. This is often forgotten, placing a long, front-view dimension in the foreshortened front planes of the face. The planes of the front of the face are radically foreshortened in the profile view of the head. (Note location of the ear in relation to the zygomatic arch and jaw.)

3-38



3-39





3-40

baffle partially covering the concha. The lobus (lobe), an extension of softer tissue, is below.

To fully appreciate the relationships of the many forms in the head, the head should be studied and drawn in all possible views—from above, from below, from the side, and partially turned from the back, and so on. When no model is available, the student may draw self-portraits, using two mirrors angled against each other to reflect a wide range of views (including the profile). Lighting the head for study is important. A single source of overhead light will help reveal large planes and the eye cavities. A movable light fixture with a clamp will permit experimentation to reveal and emphasize different aspects of the form.

3-40
Head of a Negro (charcoal) by Albrecht Durer. (Graphische Sammlung Albertina, Vienna.)
The strong planes on the side of the head may be compared with those in the work by Degas [3-10].

HAIR

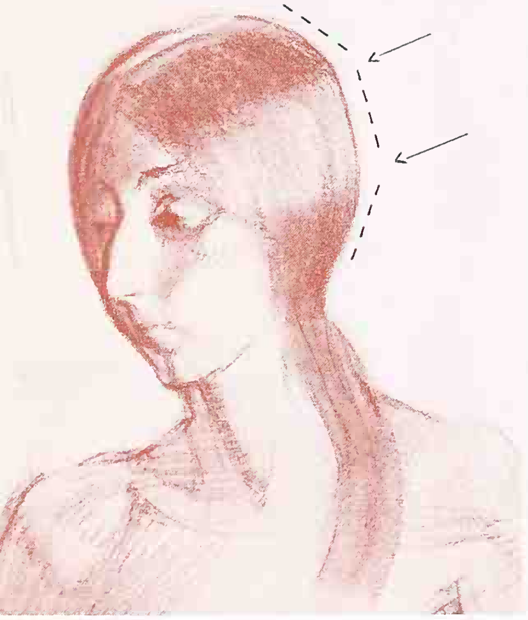
Like leaves on a tree, hair fibers and curls are baffling in form and difficult to generalize in drawing. Delicacy of surface and numerous highlights create an additional visual barrier. They disguise the hidden cranial structure.

It is not easy to present a simple rule of thumb in drawing to cover the problems presented by the unlimited variety of hairstyles. Confronted by a random cluster of curls, the student may be tempted to "fake it" by substituting a large tonal smudge. But this solution, born of frustration, will only result in an indifferent study, lacking spatial credibility.

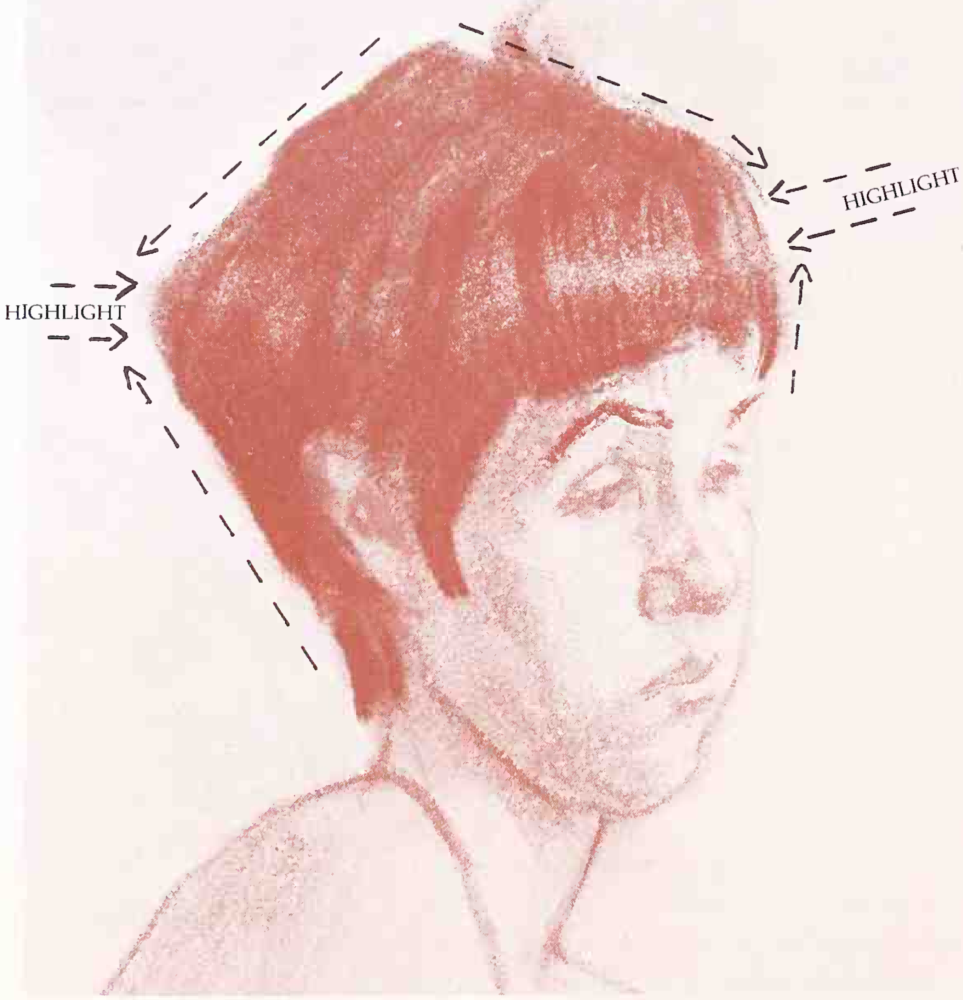
Initial consideration must be given to the underlying egglike cranial form (see p. 58). Concealed by the hair, this skeletal volume dictates the major planes of the hair mass. Although subtly rounded as a form, the cranium contains a number of significant related prominences. From the outer cover of the frontal bone (forehead) framing the eye cavity, the superior temporal ridge arches back to the parietal eminence, the widest dimension of the braincase. This ridge demarks the top curve of the cranium from the side temple plane (see illustration 3-4). The parietal eminence aligns diagonally above and behind the mastoid process (behind the ear). This lineup determines the change from the side plane to the back of the head (see illustration 3-4). In horizontal sequence are the opening

3-41
Hair Study by the author (Photograph by Iso Papo.)

Hair that hugs the cranial form is generally the easiest to explain in drawing. The contact between the planes of dark and the planes of light will coordinate with the change of direction in the contour.



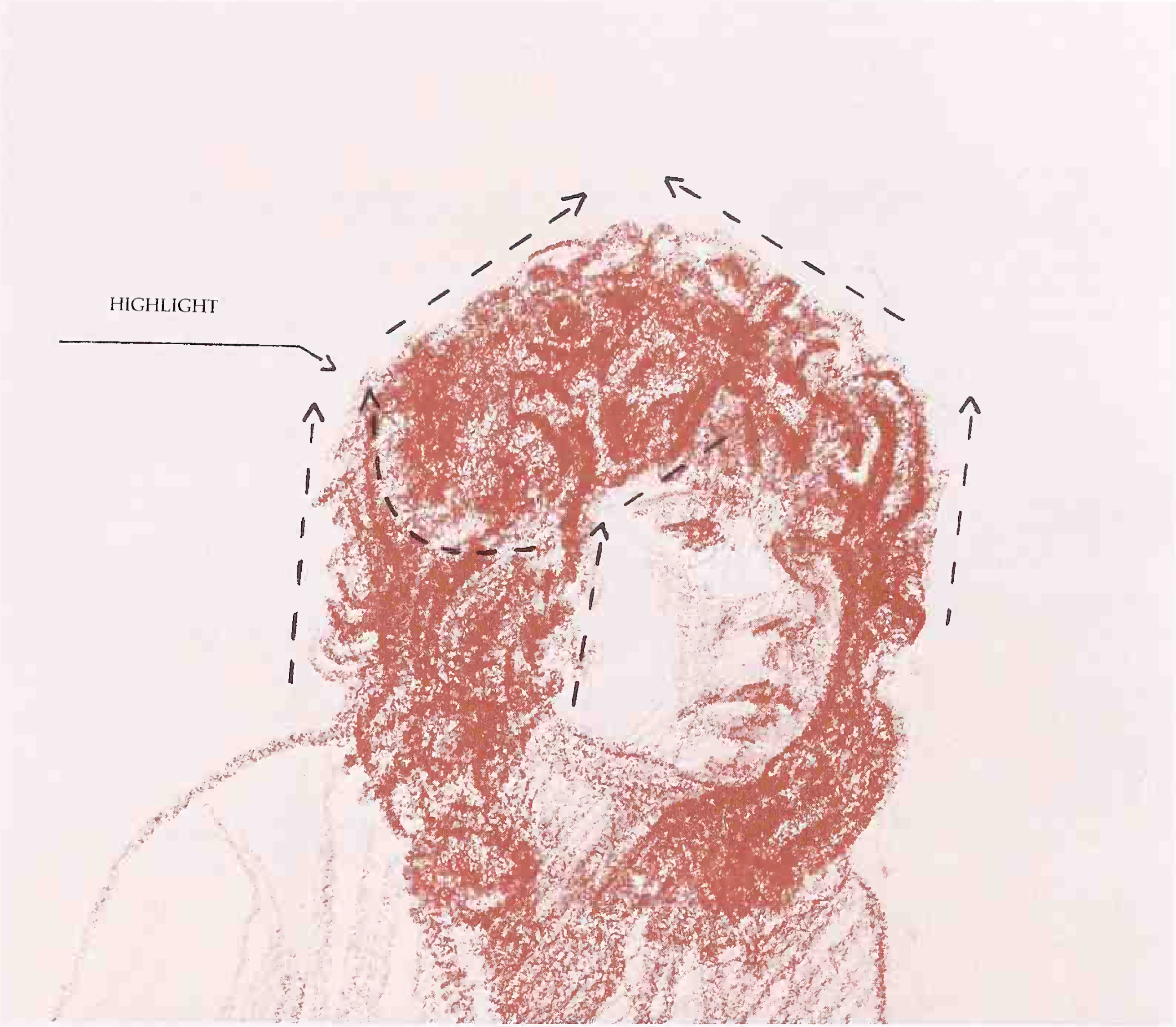
3-41



3-42

3-42
Silhouette and Highlights: Head Study by the author. (Photograph by Iso Papo.)

Fairly straight contours in the silhouette of the hair mass may also be related to broken highlights moving across the hair form. It is important not to view small highlights independent of a larger order. Arrows indicate the movement of connected lights across the form. These related lights establish the division of major large planes in the form.



3-43
Complicated Curls: Study by the author. (Photograph by Iso Papo.)

Clusters of disheveled curls in the hair are the most difficult to relate to skeletal structure and the features. Significant big directions are the first important alignments to identify. These alignments may be lightly indicated or may be kept in mind. However, the irregularities of individual curls must align with the order of major directions of all contours enclosing the hair mass. There are usually parallels or near parallel relationships at the side and top contours over the cranial structure.

of the ear, the zygomatic arch, and the cheekbone. This direction of bone completes a rough parallelogram, defining the side plane of the head.

Major angles in the silhouette (contour) will often intersect with the sharpest highlights in the hair. The relationship of highlight to contour will help clarify major planes in the hair form [3-41]. If highlights are separated by dark breaks in the hair, squinting will eliminate details and help focus on important, connected movements of light [3-42]. Once major surface changes have been identified, smaller forms (i.e., curls) may be convincingly integrated with the total hair form [3-43].

The ear, covered by long hair, imposes a major intersection of large planes along its rim (the helix). This may be revealed as a diagonal highlight above and behind the jaw (ramus of the mandible).

Special effort is recommended in drawing the silhouette of the hair form. Precise alignment of large directions within this shape will help identify scale and character [3-44, 3-45, 3-46].

3-44

Convergence in Hair and Head.

The direction of highlights in the hair will frequently conform to the principle of convergence, a general characteristic of perspective. It need not be adhered to in a rigid grid, plotted from a ground plan. The application of the convergence principle implies an orderly scheme of vanishing points (or vanishing ring) to which all receding directions will conform. The direction of highlights in the hair will frequently conform to the overall perspective of the head. Note the parallel alignment of the eyes and these long highlights.

3-45

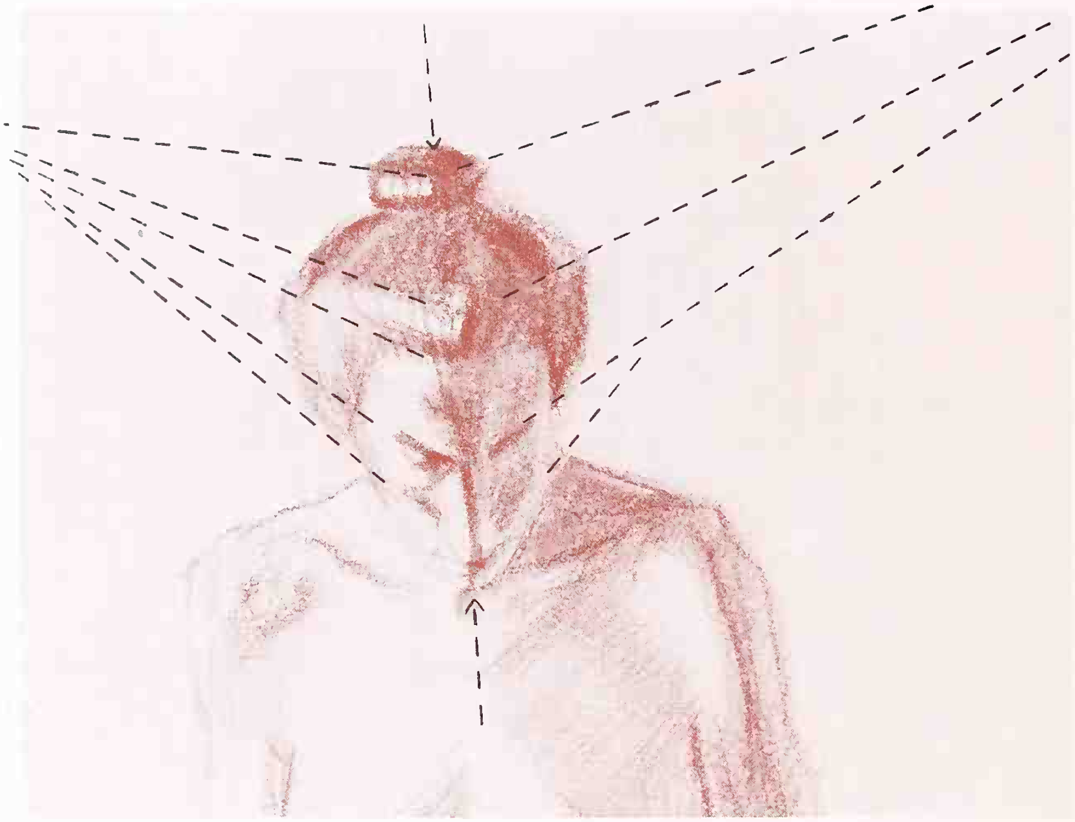
Detail from How Sweet It is to Do Nothing (mixed media) by Jacques Villon (R. M. Light and Company, Inc., Boston. Photograph by Kalman Zabarsky).

Analysis of broad underlying plane structure in the hair from a figure in Villon's drawing.

3-46

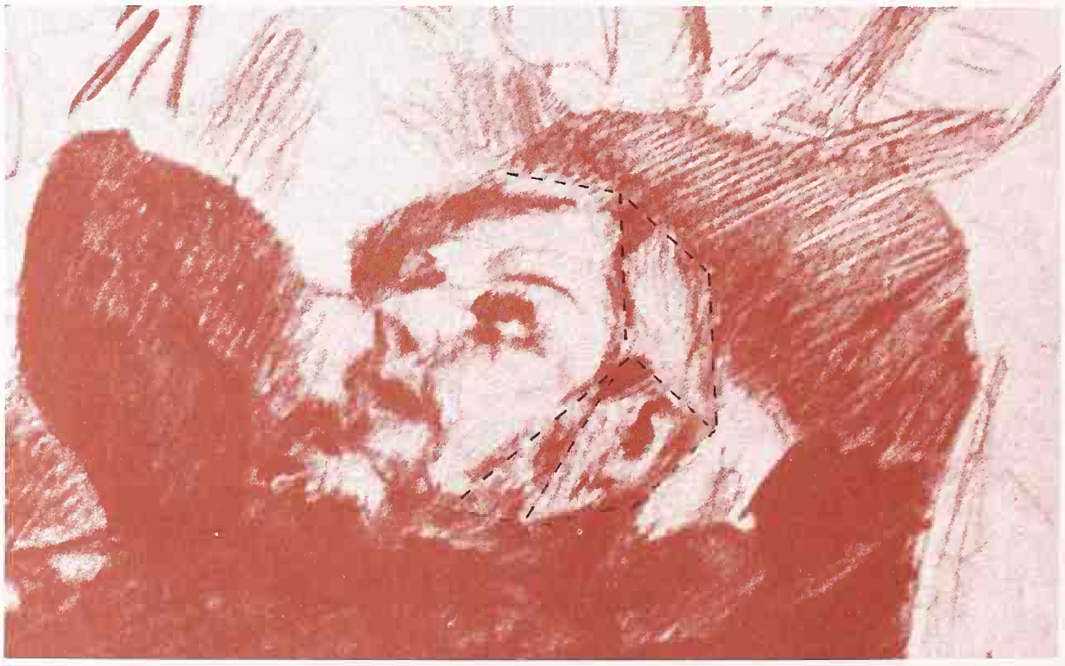
Girl with Eyes Cast Down by the author. (Photograph by Iso Papo.)

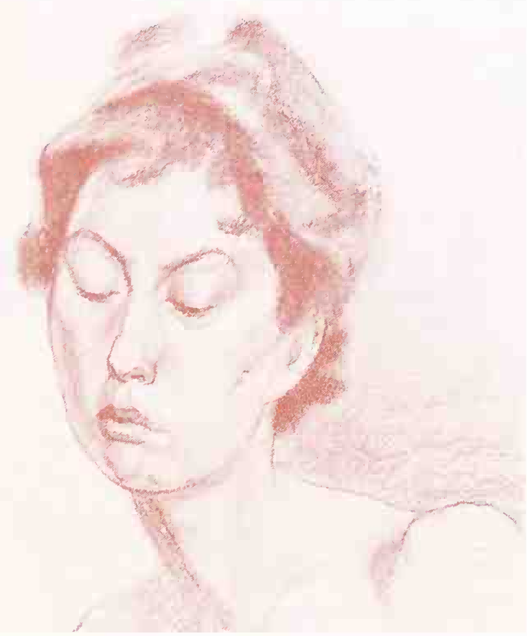
The large planes in the hair are set firmly against the cranium. The relationship between irregular detail and underlying structural architecture are equally visible.



3-44

3-45





3-46

Study Assignment

Skull and Muscles of Expression

Draw a skull and a self-portrait: focus on surface influence of bone at the jaw, forehead, cheek, nose, and so on.

1. Examine head from a three-quarter view, from the front, and slightly from below (looking up at skull).
2. Side view: self-portrait may be drawn with use of two mirrors angled to show profile.

Muscle study should emphasize influence of zygomaticus major, masseter, orbicularis oris, and cartilage of the nose and ear.

Alternate Assignment

Over a careful drawing of the skull with an overlay of tracing vellum, draw muscles of expression. For an additional exercise, see caption for illustration 3-28 (Prud'hon's *Portrait Head of a Man*).

THE NECK

The Skeleton and Cartilage

seven cervical vertebrae
hyoid bone

The Cartilage (of the larynx)

thyroid cartilage
trachea
cricoid cartilage

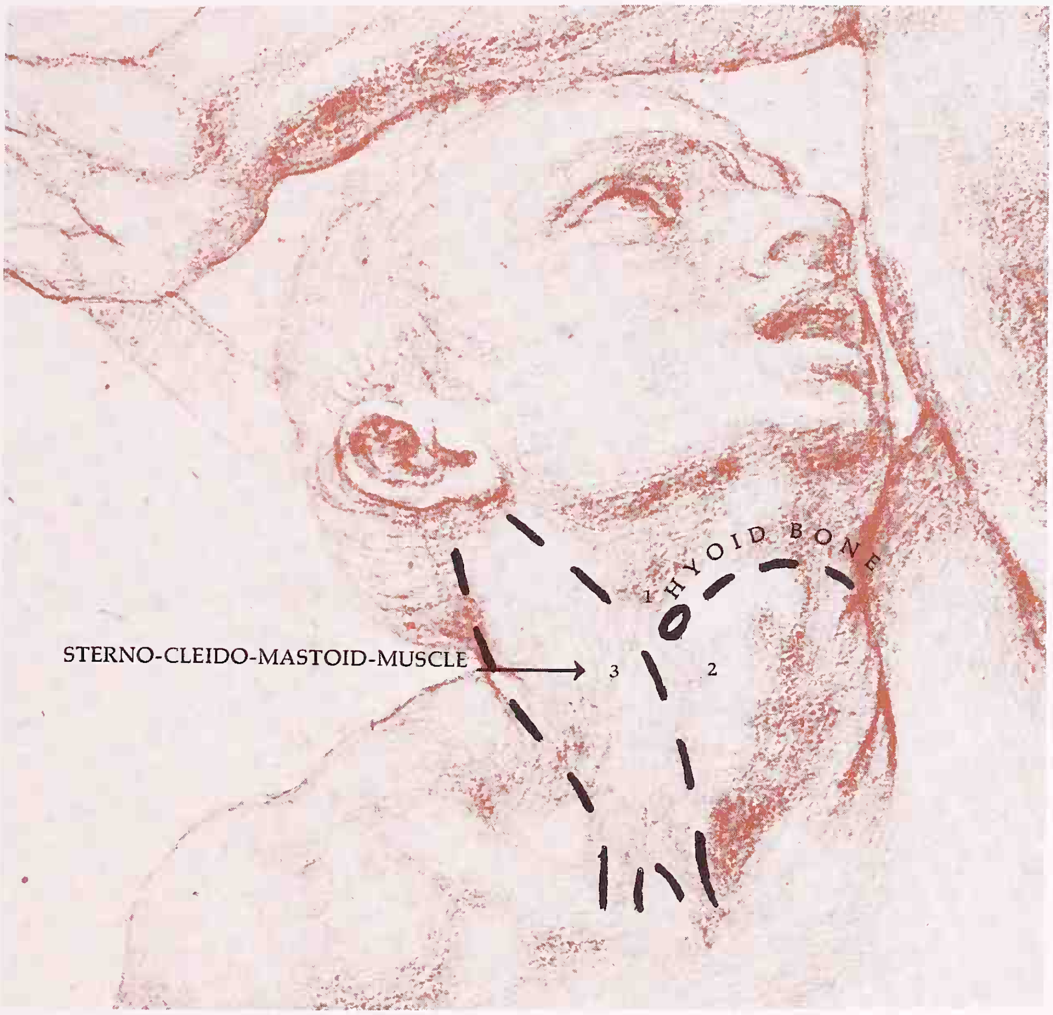
Neck Muscles

sterno-thyroid	depressors of hyoid bone
thyro-hyoid	
sterno-hyoid	
omo-hyoid	
digastric	elevators of hyoid bone
stylo-hyoid	
mylo-hyoid	
genio-hyoid	

scalene
levator scapulae
complexus
splenius
trapezius
sterno-cleido-mastoid
platysma myoides
(Two glands pad out the form:
the submaxillary gland
and the thyroid gland.)

CHAPTER 4

THE NECK

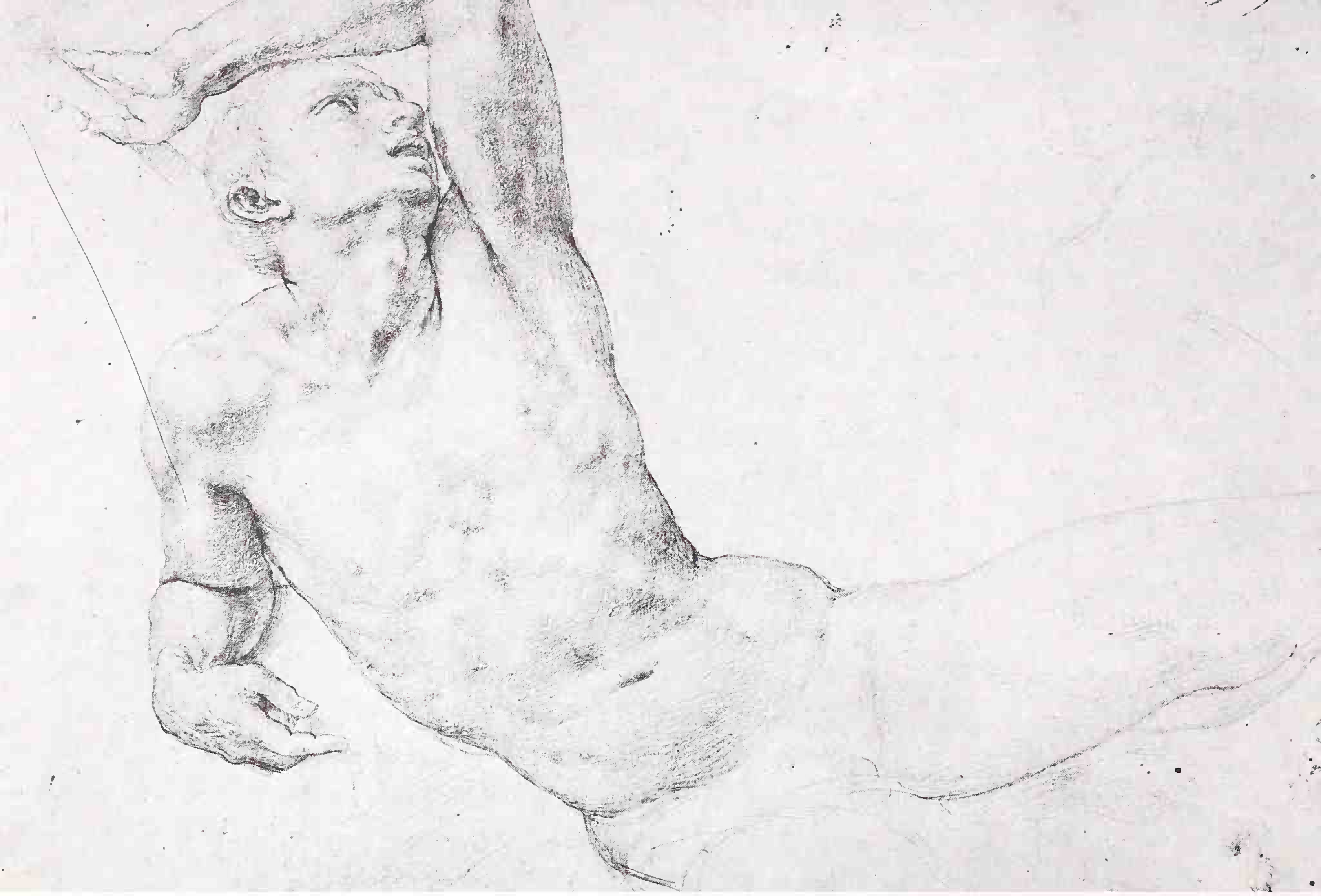


4-1
Detail from Study for a Figure by Bronzino.

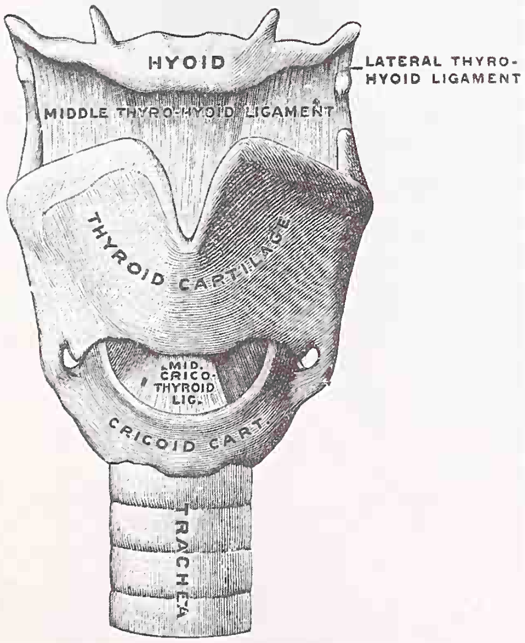
The hyoid bone is a pivotal connection between three surface areas: *(1)* the plane composed of small muscles between the jaw and hyoid bone; *(2)* the thyroid cartilage and larynx; *(3)* the sterno-cleido-mastoid muscle.

The general axis of the neck in profile is determined in back by the cervical curve of the vertebral column, paralleled in front by a visible axis running through the larynx. It begins above the larynx at the hyoid bone and ends, below it, at the pit of the neck. The cylindrical character of the neck is sharply modified in its form by three major anatomic structures. They are (1) the larynx and hyoid bone in front; (2) the sterno-cleido-mastoid muscle on the side and front (and back); (3) the trapezius muscle (and spinal column) at the back of the neck (from the spinous process of the seventh cervical vertebra to the base of the skull). The deeper musculature, especially at the back of the neck, is important to the fullness of volume, but the framework of spatiality is determined primarily by the three form units listed above.

From the front, the link between the planes of the head and neck [4-1] is the hyoid bone, the pivotal connection between three surface areas [4-2]. These areas are (1) the plane, behind and under the chin and enclosed by the mandible (and the muscles of this region, the digastric and the mylo-hyoid); (2) the form of the larynx (dominated by the thyroid cartilage and its notched prominence, the Adam's apple); (3) the sterno-cleido-mastoid muscle (running diagonally across the neck from the base of the skull, behind the ear, to the pit of the neck).



4-2



4-3

4-2

Study for a Figure in the Resurrection Altarpiece, Church of the Annuziata, Florence (black chalk on white paper), by Bronzino. (Isabella Stewart Gardner Musuem, Boston.)

The head, neck, and shoulder girdle have been clearly articulated in this drawing.

4-3

Hyoid Bone and Thyroid Cartilage, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The notch in the thyroid cartilage is popularly referred to as the Adam's apple. It projects forward and is an identifiable wedgelike form in the neck.

The key position of the U-shaped hyoid bone in the relationship of forms, seen from the front [4-3], is well illustrated in the accompanying drawings by Bronzino and Boccioni [4-2, 4-5]. The inner contour of the sterno-cleido-mastoid muscle forms the rear limit of the plane under the chin and the larynx [4-3, 4-4].

Shaped like a horseshoe, the hyoid bone has no direct attachment to other bones of the skeleton. Its position is maintained by a network of supporting muscles and by the tongue. The hyoid bone rests within the larger framework of the mandible (jawbone), slightly below, and repeats the arched form of the mandible on a smaller scale. It forms the angle of the plane enclosing the surface beneath the jaw and behind the chin. The muscles that fill out this space and elevate the hyoid are the mylo-hyoid, the digastric, the stylo-hyoid, and the genio-hyoid.

4-4

Raised Skull with Muscles of the Neck **(lithograph), from** Anatomie de L'Homme **by Jules Cloquet. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)**

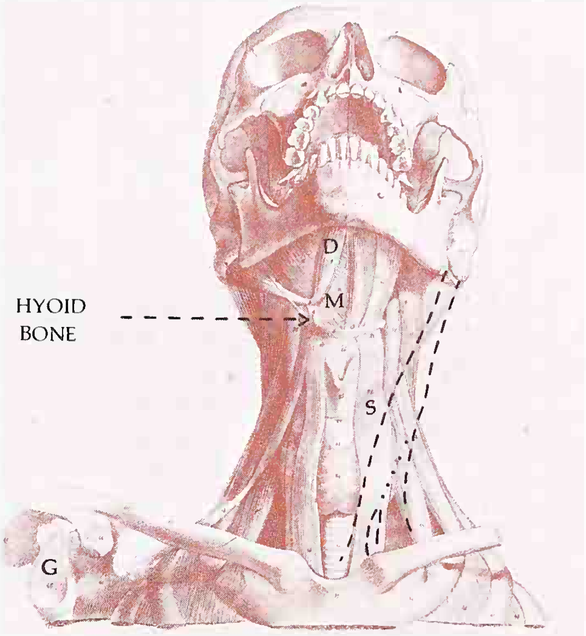
The important units in the neck that influence its surface and volume from the front are: the hyoid bone (arrow); the larynx and its notched thyroid cartilage (Adam's apple); the thyroid gland below; and the sterno-cleido-mastoid (dotted line). The following muscles are also superficially influential and should be noted: the digastric *(D)*; the mylohyoid *(M)*; and the sterno-hyoid *(S)*. The glenoid cavity of the scapula *(G)* is shown below.

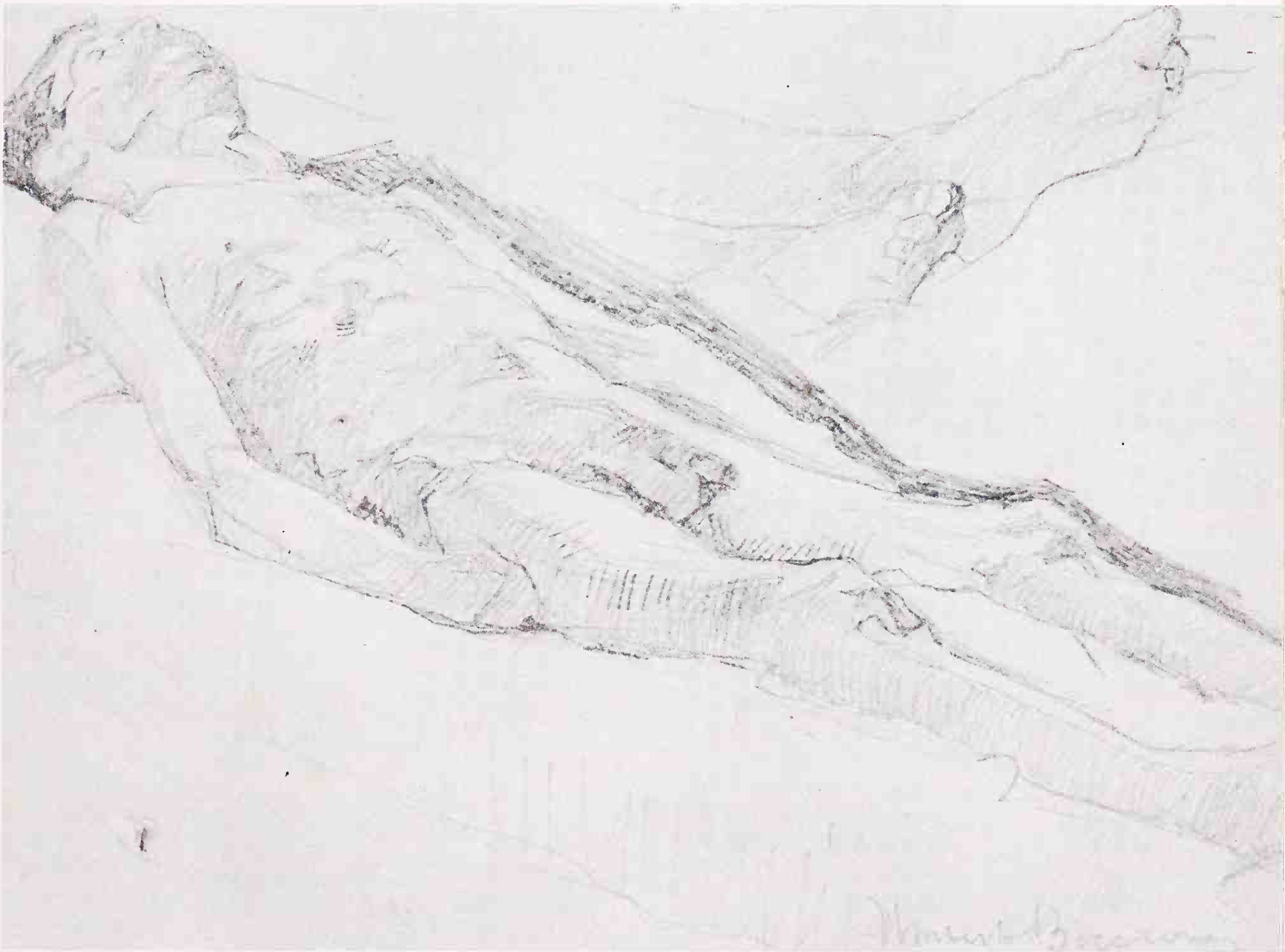
4-5

L'Annegato **(pencil, 1907) by Umberto Boccioni. (Collection: Gianni Mattioli, Milan).**

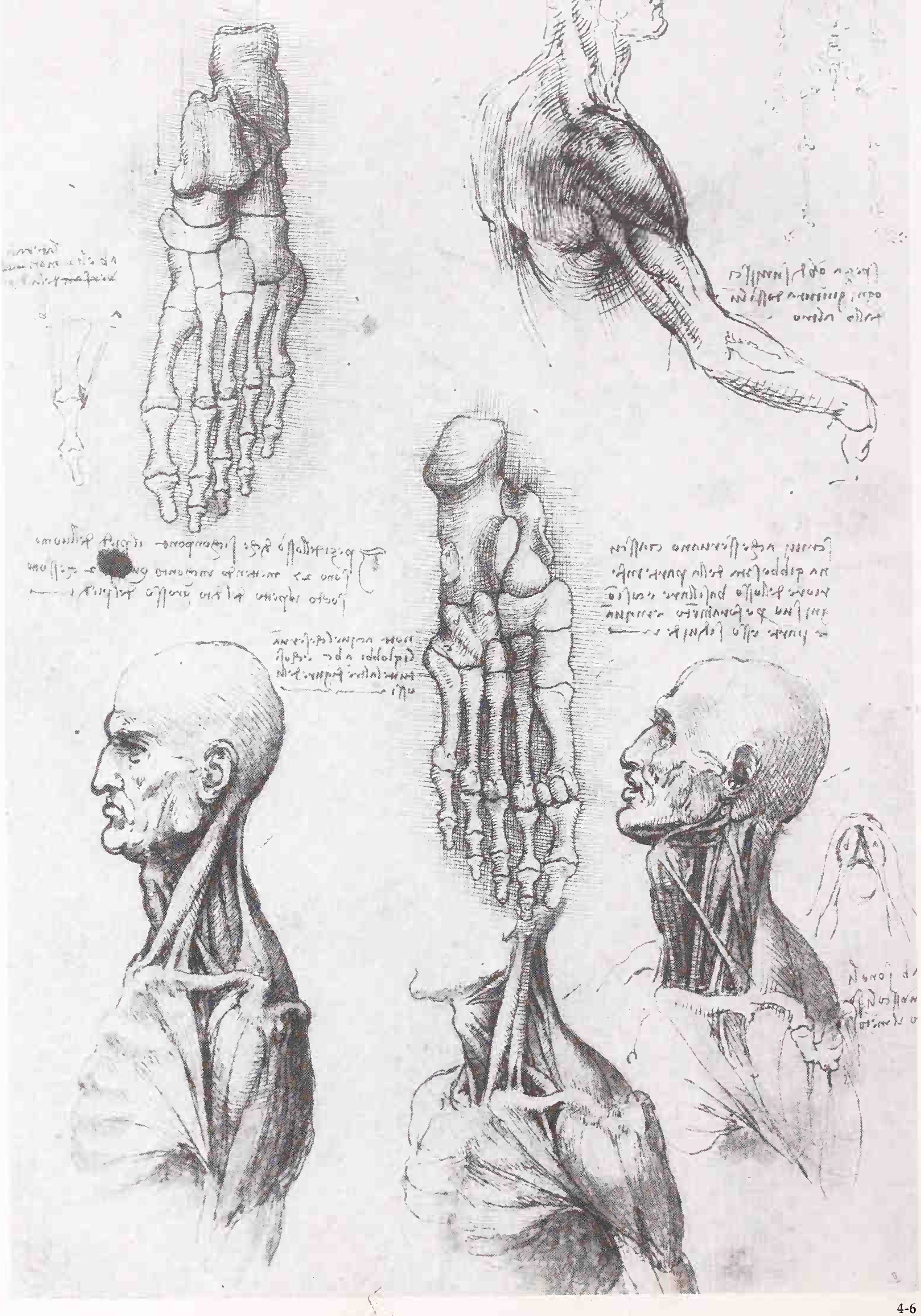
Beneath the jawline , the three forms meeting at the hyoid bone are clearly structured. They are the sterno-cleido-mastoid, the larynx, and the plane between hyoid and mandible containing the elevator muscles of the hyoid bone. (This drawing contains a carefully ordered, consistent overall perspective across the knees, the hips, and the shoulders. The near thigh is worth careful study for the curving guidelines running through the length of the form as well as the clear identification of three long planes enclosing the form from knee to hip.)

4-4





4-5



4-6

4-6

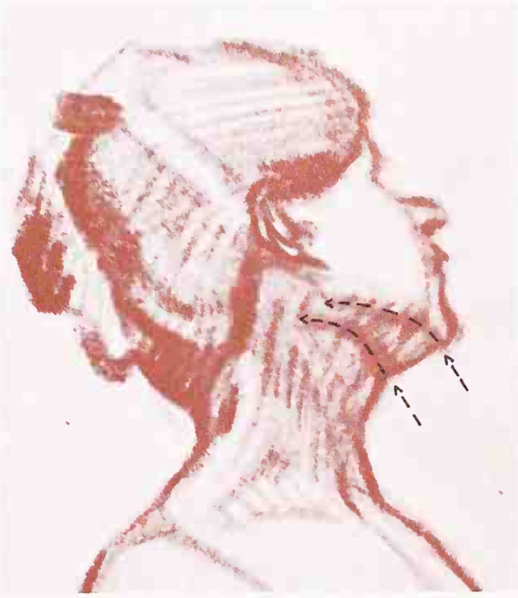
Anatomical Studies by Leonardo da Vinci. (Windsor Collection. Copyright reserved.)

Several of the drawings on this page from one of Leonardo's notebooks show his study of the muscles of the neck and shoulder. The major directional thrust of the neck is set by the cervical vertebrae (in back) and the larynx (in front). The opposing movement of the sterno-cleido-mastoid muscle (from the pit of the neck to the mastoid process behind the ear) should not obscure the main forward thrust. In some views (usually three-quarter front or three-quarter back), the fullness of the sterno-cleido-mastoid suggests a backward thrust to the neck. This may give a stiff appearance to the relationship between head, neck, and torso.

In the profile [4-6], the plane filled out by these muscles is frequently confused with the lower edge of the jawbone (mandible). This plane, behind and under the chin and jaw, should be carefully identified. The direction of the jawbone and the muscle contour formed below it by the digastric muscle form a foreshortened, thin, wedgelike plane bending in toward the neck [4-7].

The muscles below the hyoid bone that depress it and enclose the larynx are the sterno-thyroid, the thyro-hyoid, the sterno-hyoid, and the omo-hyoid. When the head is raised and the neck is in a tensed, strained attitude, the sterno-hyoid muscle may stand forward, tendonlike, from the larynx form [4-9].

A number of deeper muscles contribute to the fullness of the back of the neck [4-6]. The deepest are the upper fibers of the erector spinae, overlaid by the complexus and the splenius. More to the side are the levator scapulae and the scalene. These are partially visible between the trapezius and the sterno-cleido-mastoid muscle.



4-7

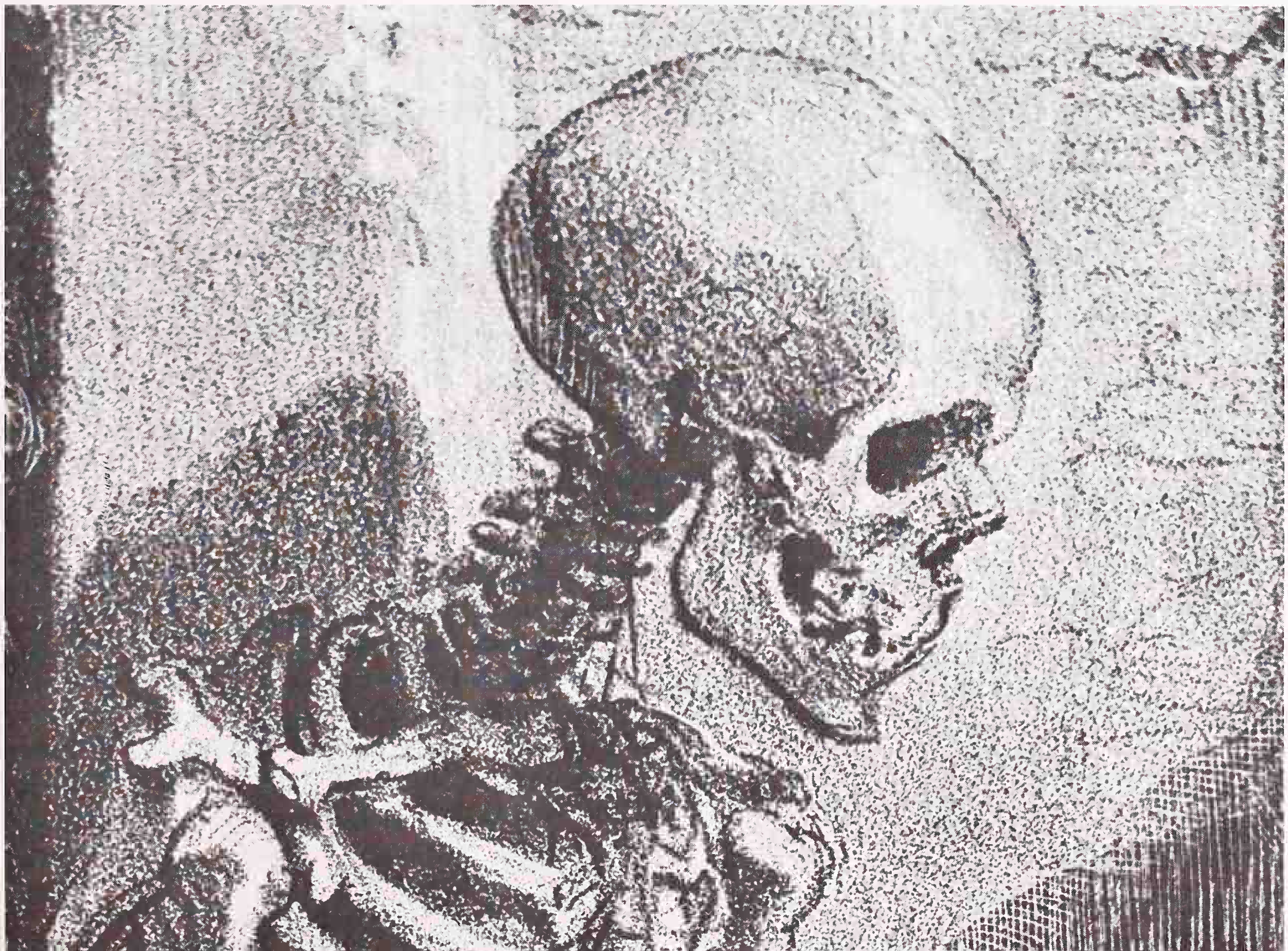
4-7
Detail from Study of a Figure by the author. (Photograph by Kalman Zabarsky.)

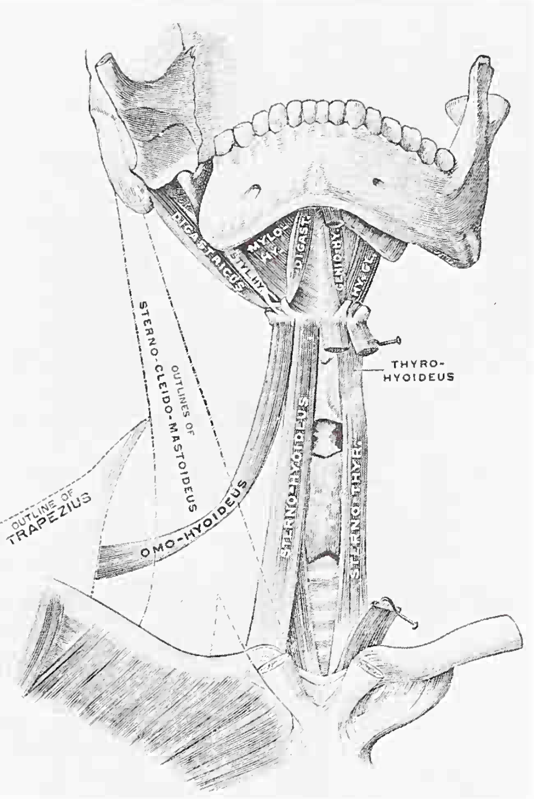
In this study, the head and neck are seen from below and the side. The plane enclosed between the jawbone (mandible) and the neck (hyoid bone) is seen from the side. This surface is frequently ignored or misunderstood in joining the head and neck. The lower arrow indicates the angle created by the hyoid bone.

4-8
Detail from Vous etes bien long, jeune homme (lithograph) by Auguste Raffet. (Collection: the author. Photograph by Kalman Zabarsky.)

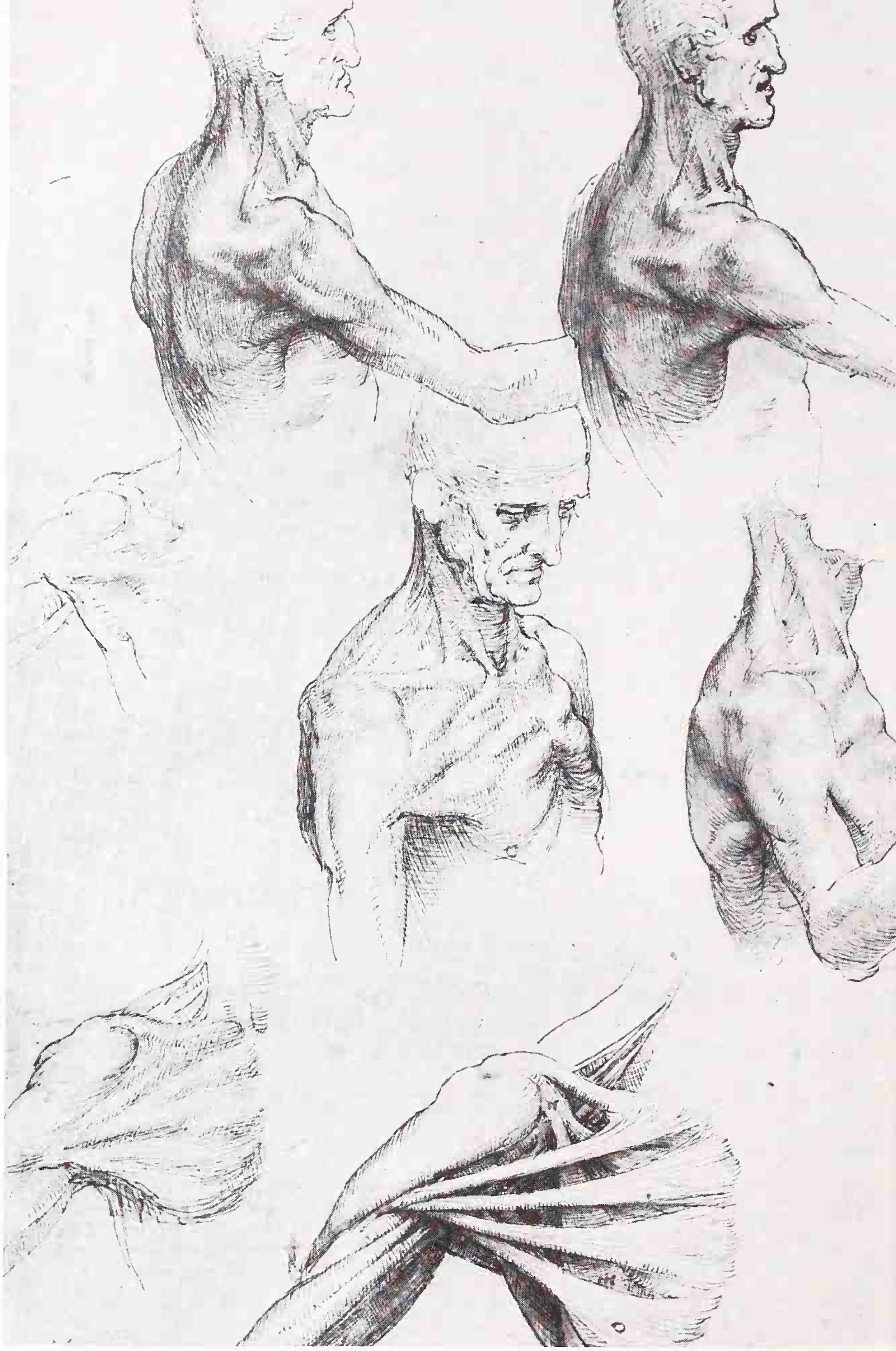
The relationship of skeletal structure in the head, neck, and shoulders as seen in this lithograph may be compared with the musculature in the center figure in the anatomical sketches by Leonardo [4-10].

4-8




DIGASTRICUS
STYL.HY.
MYLO-HY.
DIGAST.
GENIO-HY.
HY. GL.
THYRO-HYOIDEUS
OUTLINES OF
STERNO-CLEIDO-MASTOIDEUS
OUTLINE OF TRAPEZIUS
OMO-HYOIDEUS
STERNO-HYOIDEUS
STERNO-THYR.

4-9



4-10

4-9
Muscles of the Hyoid and Thyroid, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The muscles above the hyoid raise this bone in the act of swallowing. The muscles below the hyoid bone lower the bone in the act of swallowing.

4-10
Anatomical Studies by Leonardo de Vinci. (Windsor Collection. Copyright reserved.)

The muscles of the neck and shoulder are seen from various angles in the in this series of sketches by Leonardo. The angle of the tapezius muscle sets the relationship between the neck and shoulder planes. The distance from the trapezius, the large, high muscle extending from the shoulder to the back of the neck and the clavicle bone in front, indicates a major part of the thickness of the upper torso.

The origin of the trapezius muscle at the base of the cranium (occipital protuberance) creates a clear change of plane direction between the curve of the skull and the flatter surface of this muscle [4-10]. The trapezius muscle covers an extensive area of the upper back, spreading out to the shoulders and covering part of the scapulae. The part relevant to the neck forms a modified triangular plane with its apex at the back (occipital ridge) of the skull and spreads to a broad base ending at each shoulder. The distance from the angle of the trapezius, between the neck and shoulder running forward to the sternal attachment of the clavicle, indicates part of the thickness of the upper torso [4-10, 4-12].

4-11

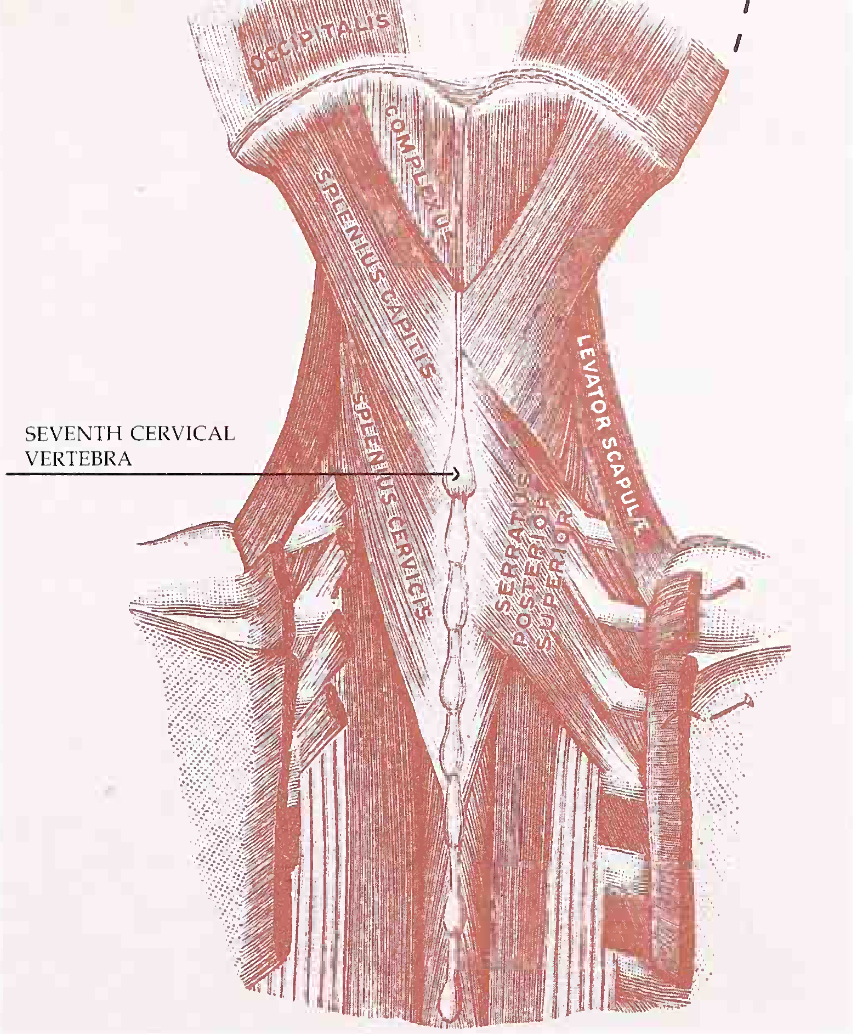
Complexus, Splenius, and Levator Scapulae, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

These are the deeper muscles in the back of the neck beneath the trapezius. They fill out the form of the neck and are partially visible from a side view (see illustration 4-12).

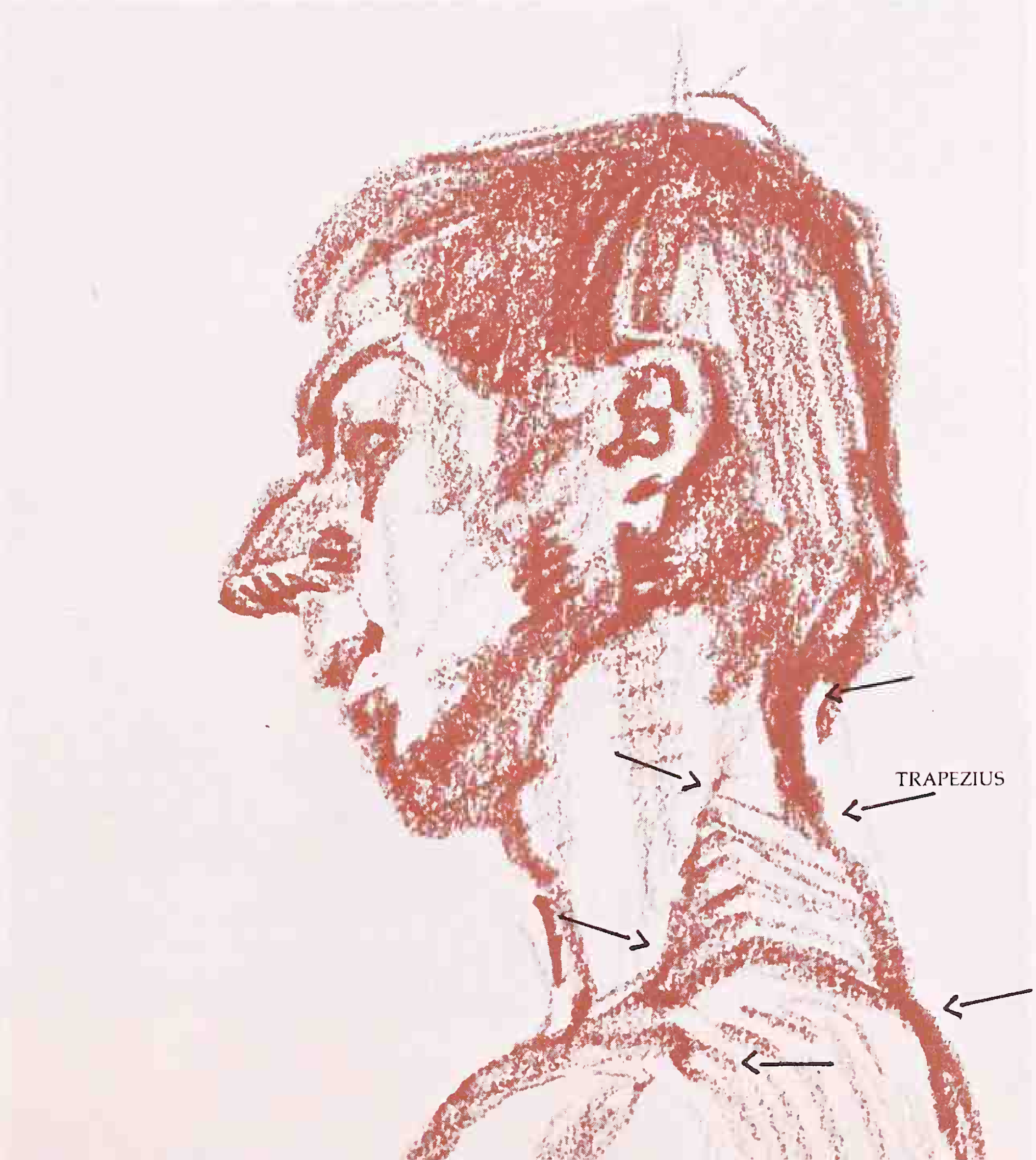
4-12

Study of the Head and Neck by the author. (Photograph by Kalman Zabarsky.)

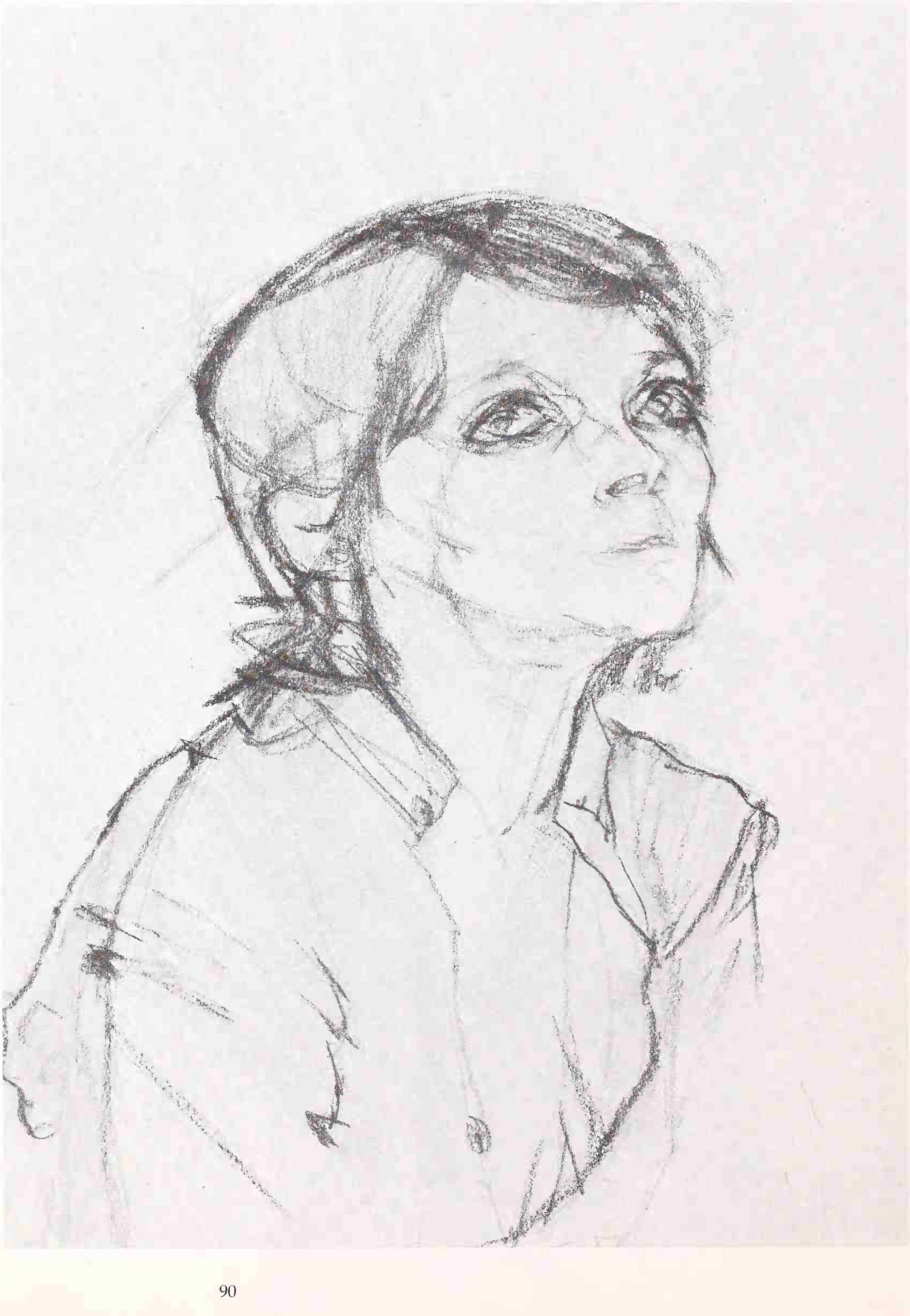
The thickness of the trapezius muscle is indicated as it proceeds from the shoulder to the base of the skull in the back of the neck. Observe also jaw and neck relationships and the plane enclosing the jaw.


OCCIPITALIS
COMPLEXUS
SPLENIUS CAPITIS
LEVATOR SCAPULAE
SEVENTH CERVICAL VERTEBRA
SPLENIUS CERVICIS
SERRATUS POSTERIOR SUPERIOR

4-11

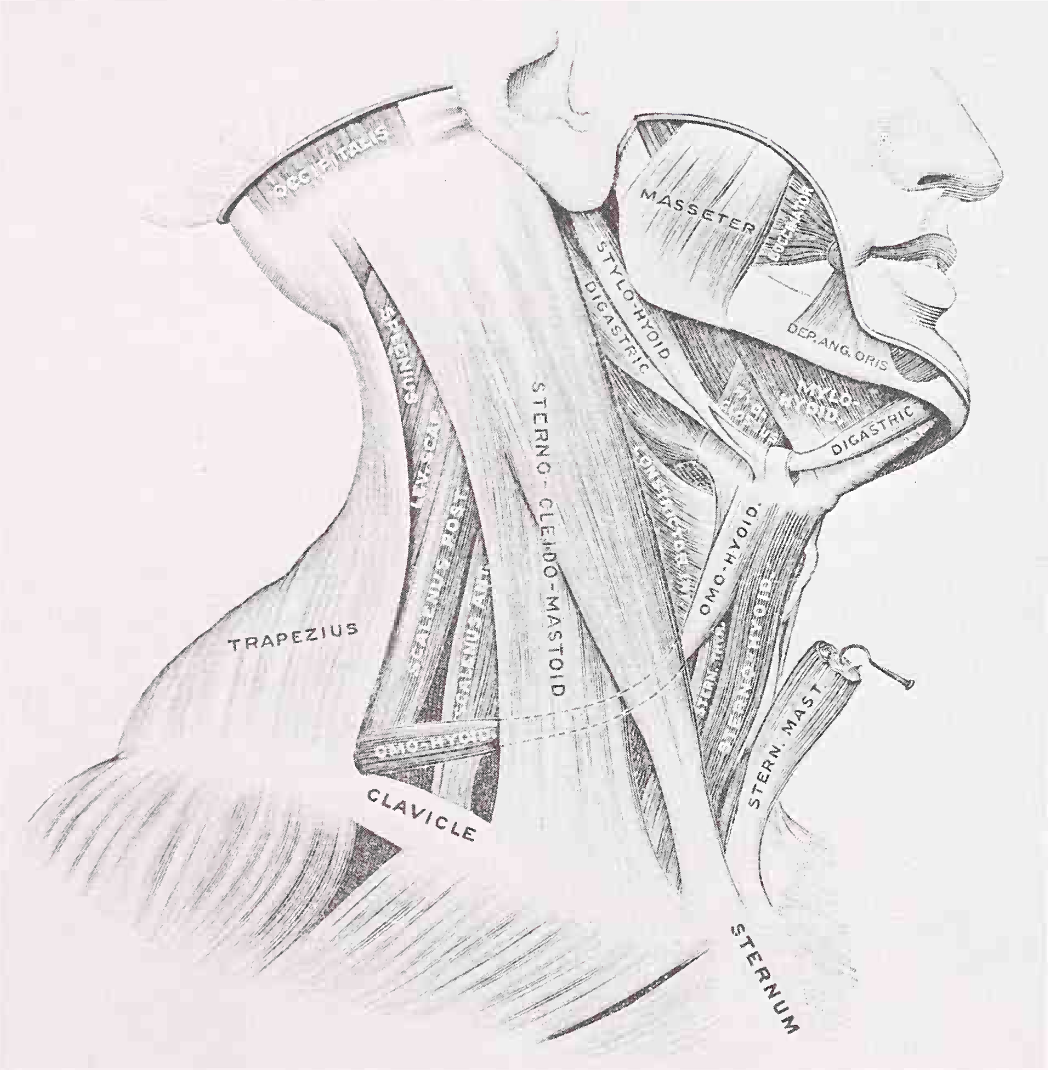


4-12



4-13

Two prominent strands of muscle embrace the neck on each side, running diagonally across the form. This muscle, the sterno-cleido-mastoid, can confuse the direction of the neck, especially when seen from a three-quarter back view. Since it runs diagonally across the neck from an upper attachment (insertion) at the mastoid process (behind and under the ear) to its two lower points of origin at the sternal end of the clavicle and the manubrium, it should be carefully observed in relation to the overall axis of the neck [4-14, 4-15, 4-16].


OCCIPITALIS
MASSETER
BUCCINATOR
STYLO-HYOID
DIGASTRIC
DEP. ANG. ORIS
MYLO-HYOID
DIGASTRIC
SPLENIUS
LEV. SCAP.
STERNO-CLEIDO-MASTOID
CONSTRICTOR
OMO-HYOID.
SCALENUS POST.
SCALENUS ANT.
TRAPEZIUS
STERNO-HYOID
STERN. MAST.
OMO-HYOID
CLAVICLE
STERNUM

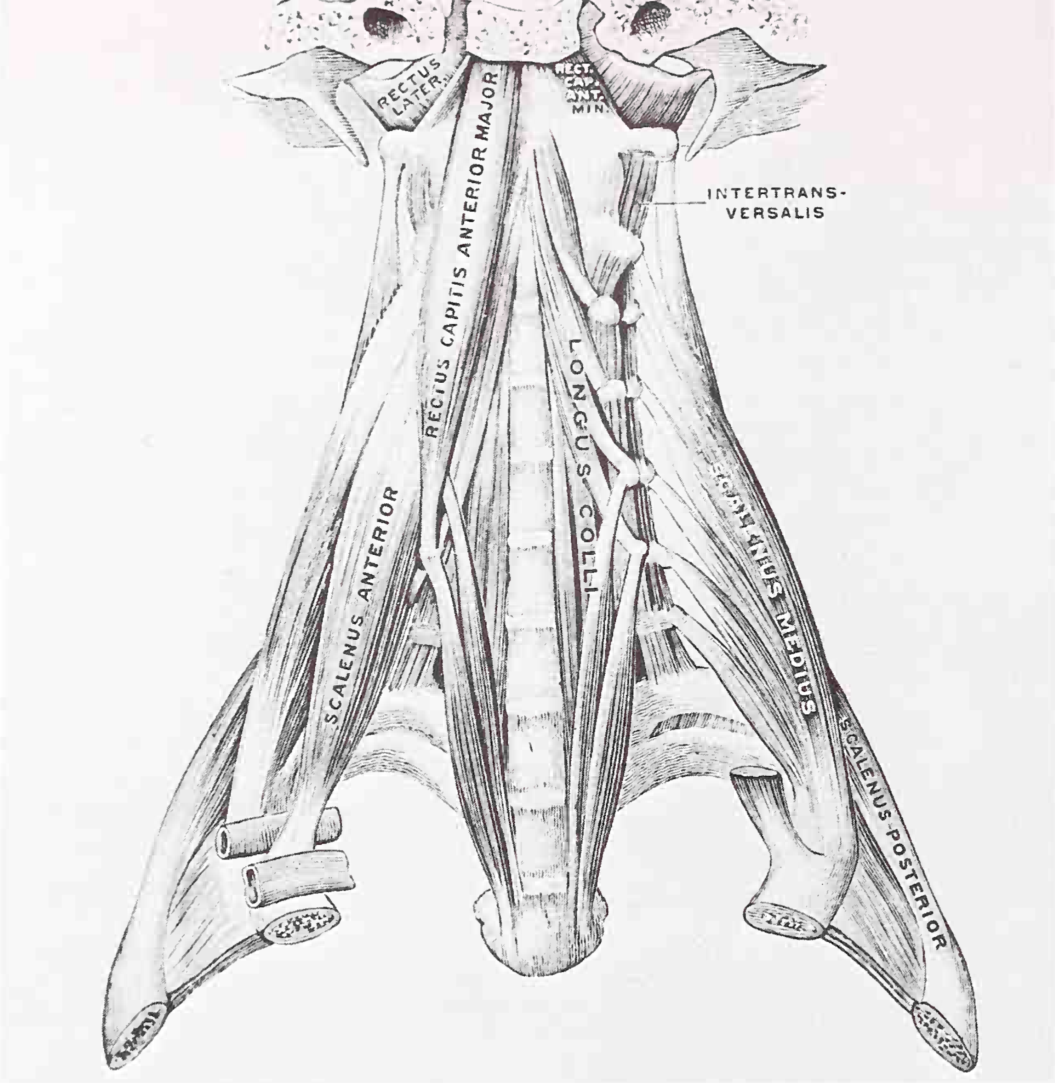
4-14

4-14
Muscles of Front and Side of Neck, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

Visible between the trapezius and the sterno-cleido-mastoid muscles are the deeper muscles of the neck. These are the splenius, levator scapulae, scalenus, and omo-hyoid.

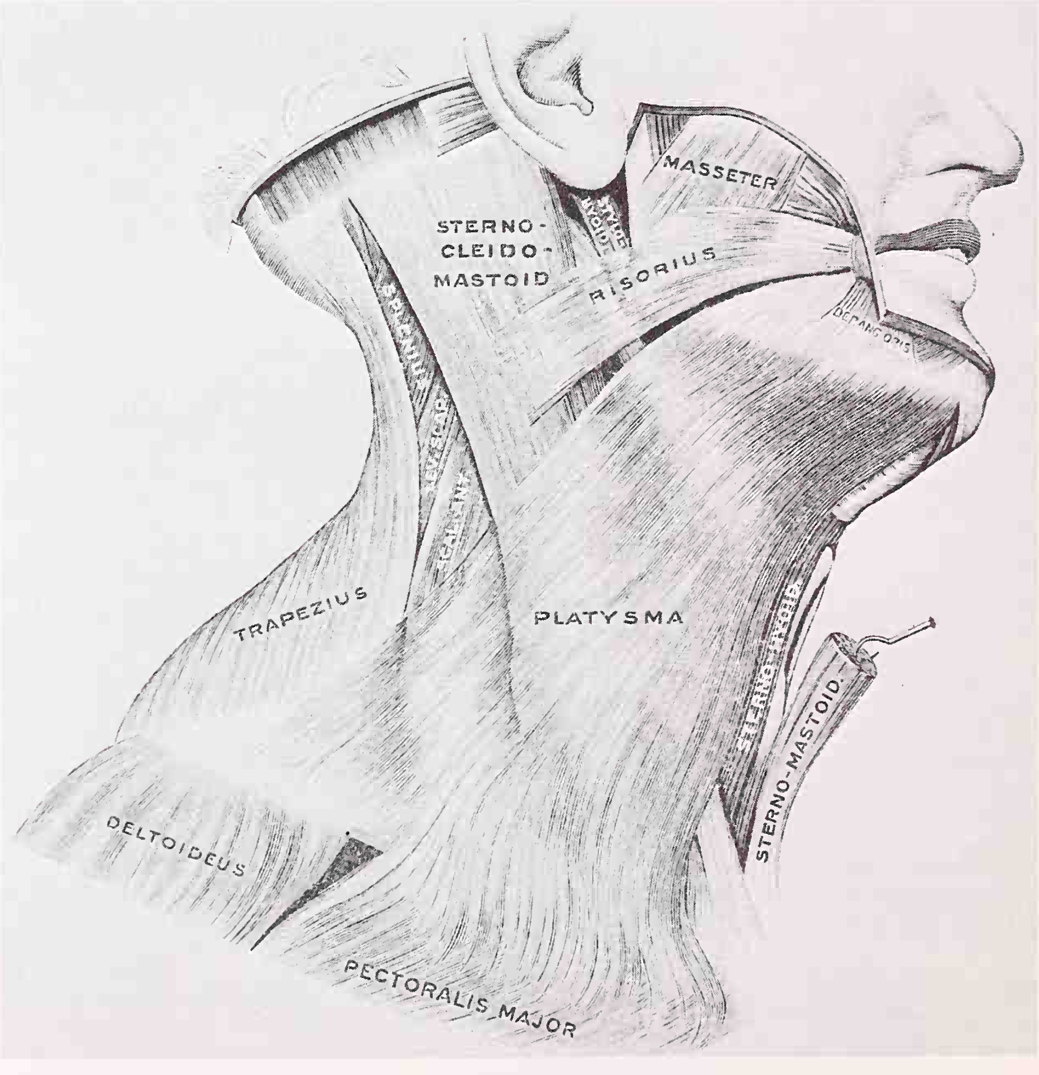
4-13
Portrait of an Italian Boy (crayon and watercolor) by Oskar Kokoschka. (Courtesy: Worcester Art Museum.)

Careful study of this drawing will reveal a beautiful order of space supporting an intensely moving, expressive figure. The neck structure and the plane behind the chin and under the jaw are clearly and economically stated. From the pit of the neck, the larynx stretches diagonally upward, and a clear line defines the hyoid bone. Parallel guidelines have been inventively employed to define planes and muscular form: the strong diagonal hairline on the side of the head at the ear, and the line from the corner of the near eye; the line over the near cheek to the jaw; the line over the near cheek to the jaw (masseter muscle), and the line in the neck (limiting the sterno-cleido-mastoid).


RECTUS LATER.
RECT. CAP. ANT. MIN.
RECTUS CAPITIS ANTERIOR MAJOR
INTERTRANS-
VERSALIS
LONGUS COLLI
SCALENUS ANTERIOR
SCALENUS MEDIUS
SCALENUS POSTERIOR

4-15

4-16


MASSETER
STERNO-
CLEIDO-
MASTOID
RISORIUS
DEPANG. ORIS
TRAPEZIUS
PLATYSMA
STERNO-MASTOID.
DELTOIDEUS
PECTORALIS MAJOR

4-15
Deep Muscles of the Neck, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

These muscles are partially visible between the trapezius and the sterno-cleido-mastoid.

4-16
Superficial Muscles of the Neck, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The platysma myoides is a thin, skinlike muscle covering the upper chest, the neck muscles, and cartilage and joining along the jawline into the lower muscles of the face. It is evident only when the mouth and neck are in a pained or strained condition.

Study Assignment

Neck Structures

Draw cervical vertebrae with skull plus upper thoracic vertebrae and upper three ribs.

Draw hyoid bone.

Draw thyroid cartilage (Adam's apple) and trachea (windpipe).

Draw muscles of neck and hyoid region on tracing vellum placed over bone and cartilage structures of neck.

THE TORSO

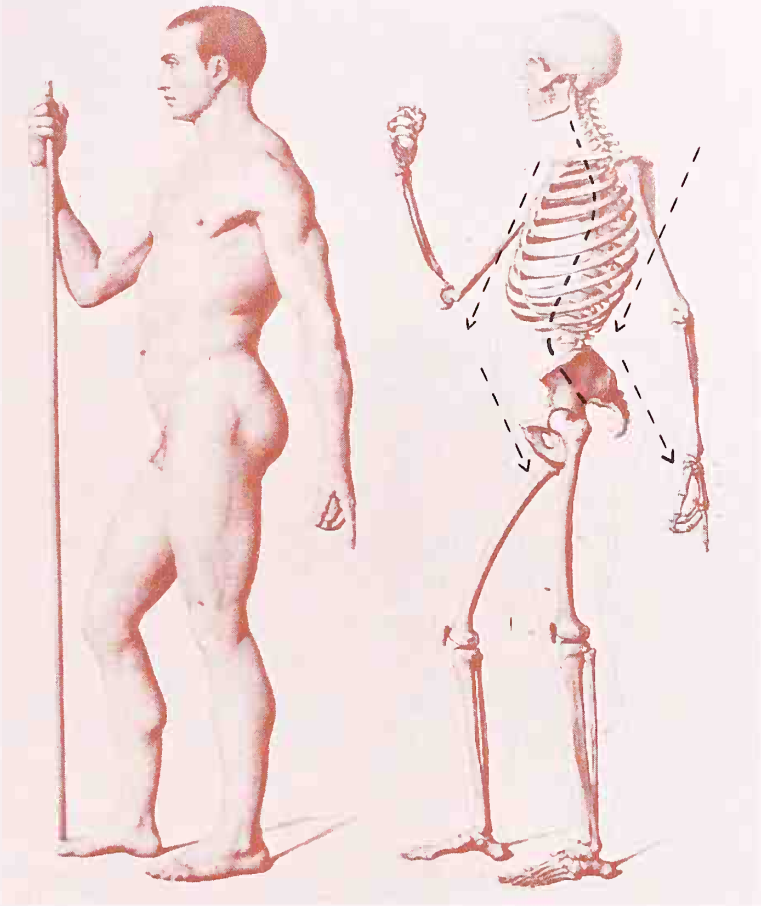
The Skeleton

VERTEBRAE
cervical (7)
dorsal (12)
lumbar (5)
vertebra: body, spinal canal, transverse process, spinous process, articular process
THORAX (RIB CAGE)
sternum: manubrium, gladiolus, xyphoid process
costae (ribs)
costal cartilage
SHOULDER GIRDLE
clavicle
scapula: acromion process, glenoid cavity, spine of scapula
PELVIS
os innominatum: ilium, ischium, pubes, iliac crest, upper iliac spine (front and back), acetabulum
sacrum
coccyx

The Muscles

TORSO FRONT
transversalis
internal oblique
external oblique
gluteus medius
rectus abdominus
Poupart's ligament (inguinal ligament)
internal intercostal
external intercostal
subclavius
pectoralis minor
pectoralis major
serratus magnus
TORSO BACK
erector spinae
complexus
splenius
rhomboid minor
rhomboid major
levator anguli scapulae
supraspinatus
infraspinatus
teres minor
teres major
trapezius
latissimus dorsi
gluteus maximus

CHAPTER 5
THE TORSO



5-1

5-1

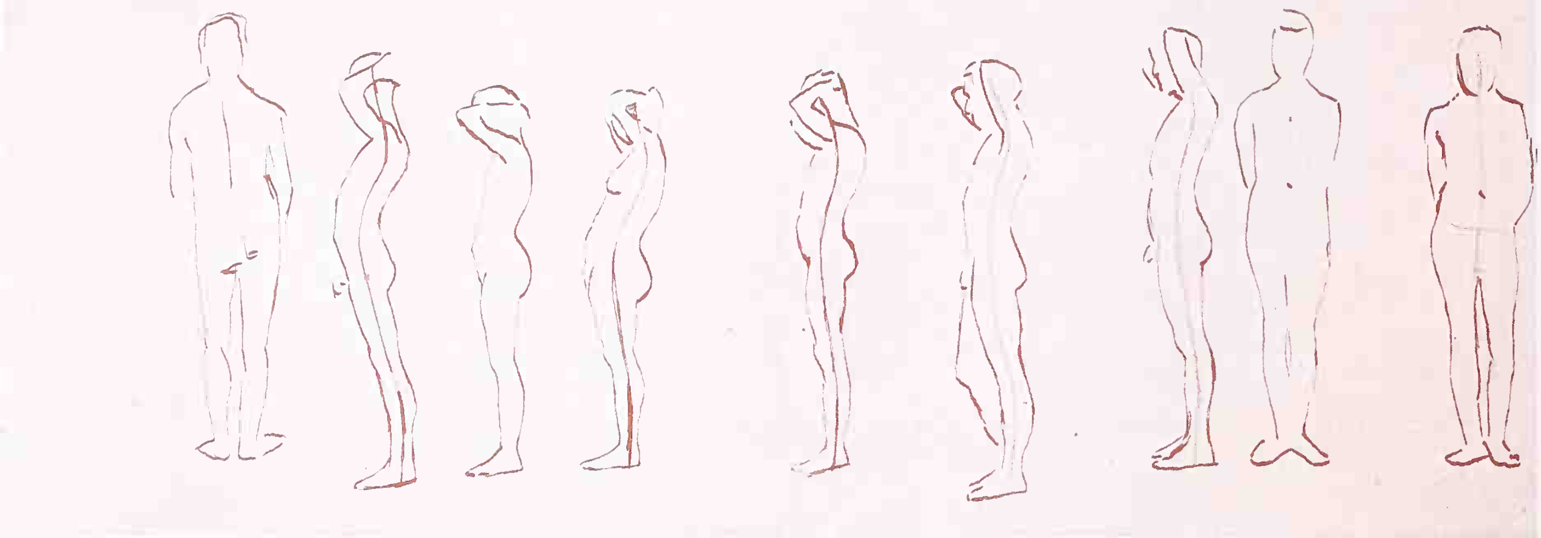
Skeleton and Figure (lithograph), from Anatomie of the External Forms of Man by Julian Fau. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The curvature of the spine governs the axis and location of the pelvis, rib cage, and skull. In the standing figure, this curve controls the opposing directions between the pelvis and the rib cage and contributes to the overall curve of the torso. The understanding of this opposing relationship is well demonstrated in the drawing by Raphael [5-10].

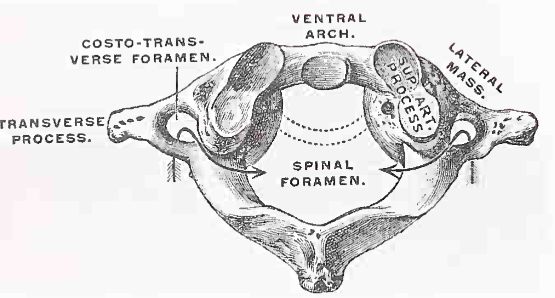
The two major skeletal forms of the torso, the rib cage and the pelvis, are united by the spine. It is the curve of the spinal column that determines their relationship. In the mature figure, in a normal erect posture, the rib cage is angled forward toward its wide base, and the pelvic structure is set in an opposing backward direction, giving an arched form to the trunk [5-1, 5-2].

THE SPINE

The vertebral column, made up of twenty-four bones, has a considerable range of movement. Roughly drum-shaped, the bodies of these twenty-four vertebrae are stacked, one upon the other, forming a strong pillar for the support of the cranium and trunk [5-3]. Movement is permitted by flexible intervertebral disks (cartilage) wedged between the vertebrae. The long, deep muscles of the back act on three short levers (processes) of bone arranged radially on each vertebral unit. In the region of the rib cage (dorsal vertebrae), two of the levers (transverse processes) provide added support for the vertebral attachment of the ribs. There are seven (cervical) vertebrae in the neck, twelve (dorsal) vertebrae for the attachment of ribs, and five (lumbar) vertebrae in the space between the rib cage and the pelvis [5-3 through 5-10].



5-2


VENTRAL ARCH.
COSTO-TRANS-VERSE FORAMEN.
LATERAL MASS.
SUP. ART. PROCESS
TRANSVERSE PROCESS.
SPINAL FORAMEN.

5-4

5-2
Nine Studies of Figure (pen and ink) by Thomas Eakins. (Hirshhorn Museum and Sculpture Garden, Smithsonian Institution.)

Eakins used photographs to identify the axis of movement and distribution of weight within the figure. Traced contour drawings of photographs were carefully diagramed to establish a center axis. In the profile view axial curves are based on the essential parallel direction of the front and back contour lines and the spinal column. The specifics of each contour (front versus back) are different. The longer relationships are parallel. In drawing from life, focusing on small contour details along one edge, the student may lose sight of an overall direction.

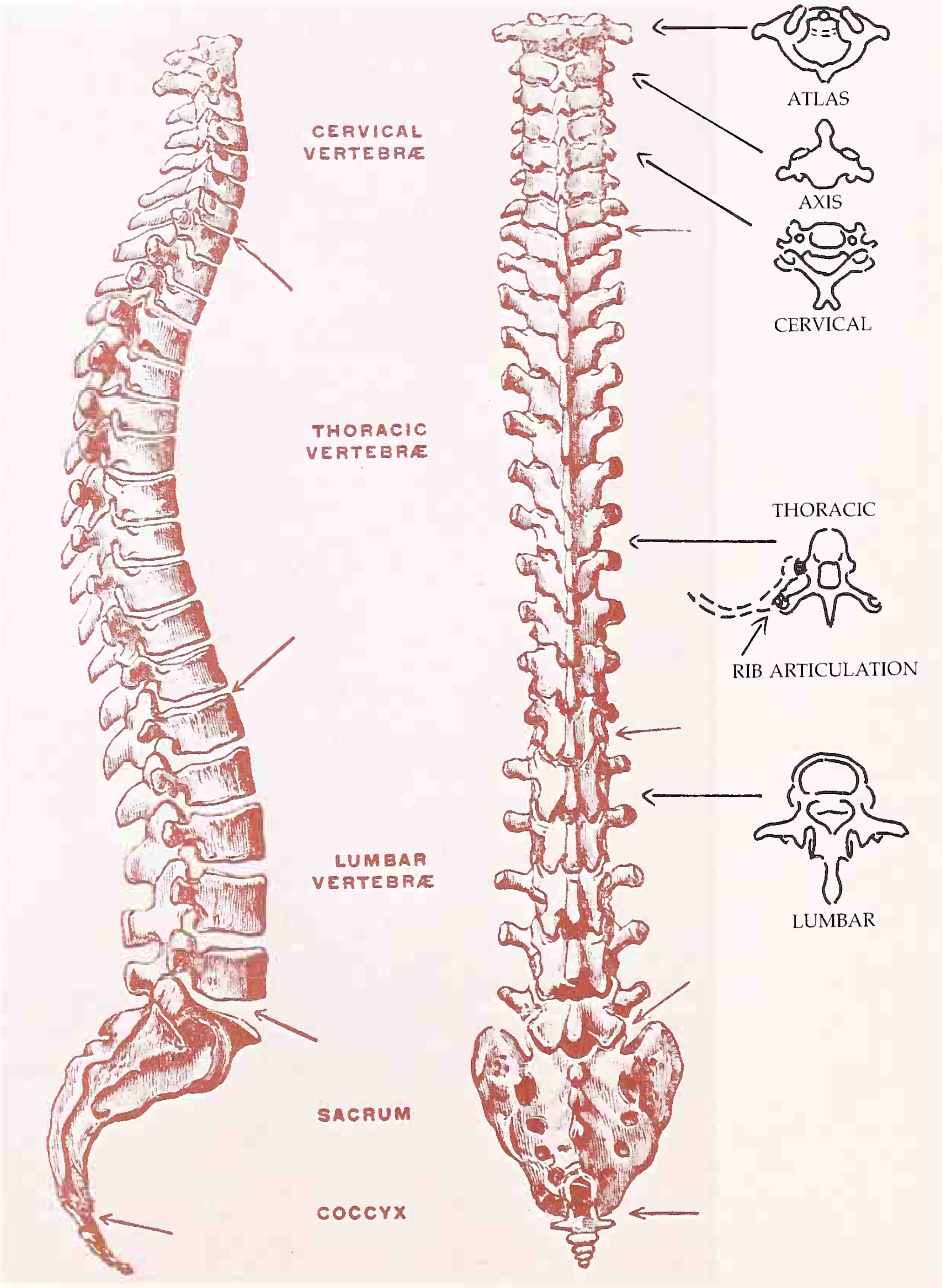
5-3
The Vertebral Column, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The position of the skull, the rib cage, and the pelvis are set by the curvature of the spine. It should be carefully established. Comparative study of the length of the cervical vertebrae, the thoracic vertebrae, and the lumbar vertebrae will contribute to gestural accuracy.

5-4
The Atlas, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The atlas is the first cervical vertebra, a bony ring that supports the skull and permits side-to-side articular movement. It is shown here from above.

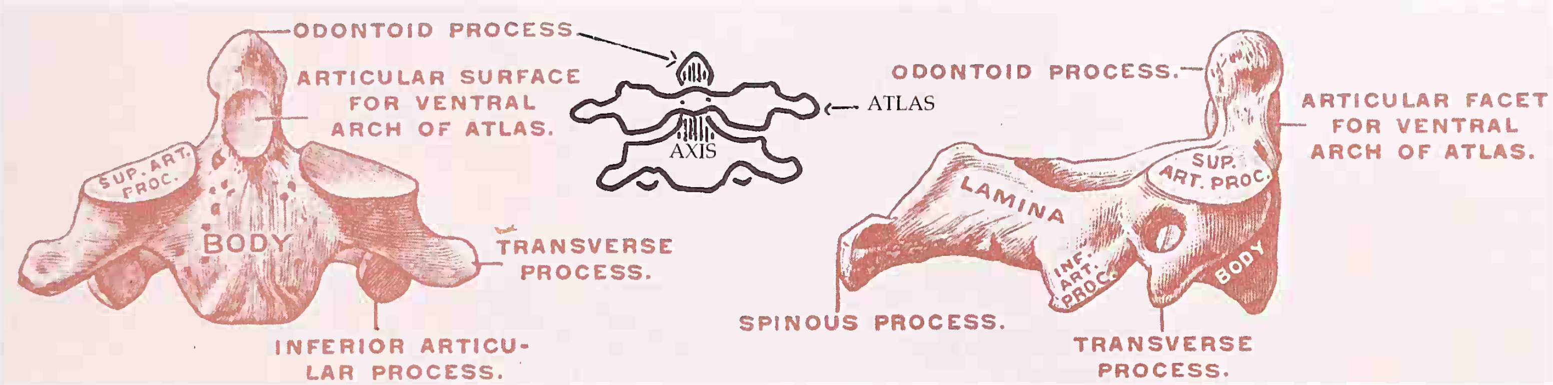
5-3


CERVICAL VERTEBRÆ
THORACIC VERTEBRÆ
LUMBAR VERTEBRÆ
SACRUM
COCCYX
ATLAS
AXIS
CERVICAL
THORACIC
RIB ARTICULATION
LUMBAR

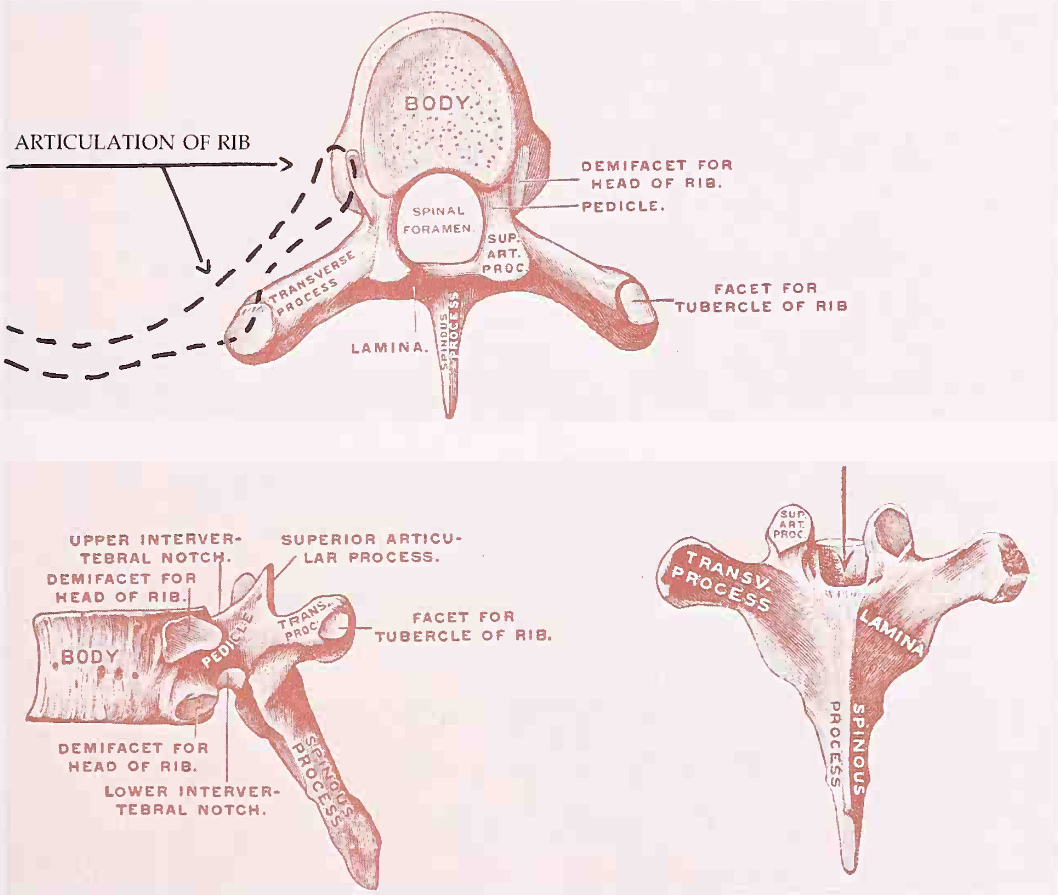
5-5

The Axis, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The axis is the second cervical vertebra. It is distinguished by the odontoid process projecting upward. The atlas rotates upon the odontoid process in the movement of the head from side to side. The axis is shown from the front (left) and the side (right).


ODONTOID PROCESS
ARTICULAR SURFACE FOR VENTRAL ARCH OF ATLAS.
SUP. ART. PROC.
BODY
TRANSVERSE PROCESS.
INFERIOR ARTICULAR PROCESS.
ATLAS
AXIS
ODONTOID PROCESS.
ARTICULAR FACET FOR VENTRAL ARCH OF ATLAS.
SUP. ART. PROC.
LAMINA
INF. ART. PROC.
BODY
SPINOUS PROCESS.
TRANSVERSE PROCESS.

5-5


BODY
ARTICULATION OF RIB
DEMIFACET FOR HEAD OF RIB.
PEDICLE.
SPINAL FORAMEN.
SUP. ART. PROC.
TRANSVERSE PROCESS
FACET FOR TUBERCLE OF RIB
LAMINA.
SPINOUS PROCESS.
UPPER INTERVERTEBRAL NOTCH.
SUPERIOR ARTICULAR PROCESS.
DEMIFACET FOR HEAD OF RIB.
TRANS. PROC.
FACET FOR TUBERCLE OF RIB.
BODY
PEDICLE
DEMIFACET FOR HEAD OF RIB.
LOWER INTERVERTEBRAL NOTCH.
SPINOUS PROCESS
SUP. ART. PROC.
TRANSV. PROCESS
LAMINA
SPINOUS PROCESS

5-7

5-7

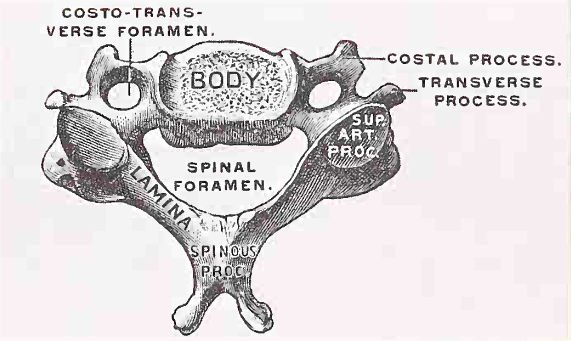
Thoracic Vertebrae, from Traité D'Anatomie Humaine Jean Leo Testut. (Photograph by Iso Papo.)

The head of a rib articulates between two vertebrae and is in contact with both. The third point of articulation is at the extremity of the transverse process. Illustrated is a thoracic vertebra viewed from the front (above), from the left side (lower left), and from behind (lower right).

5-8

Lumbar Vertebra, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

A lumbar vertebra viewed from above.


COSTO-TRANSVERSE FORAMEN.
BODY
COSTAL PROCESS.
TRANSVERSE PROCESS.
SUP. ART. PROC.
SPINAL FORAMEN.
LAMINA
SPINOUS PROC.

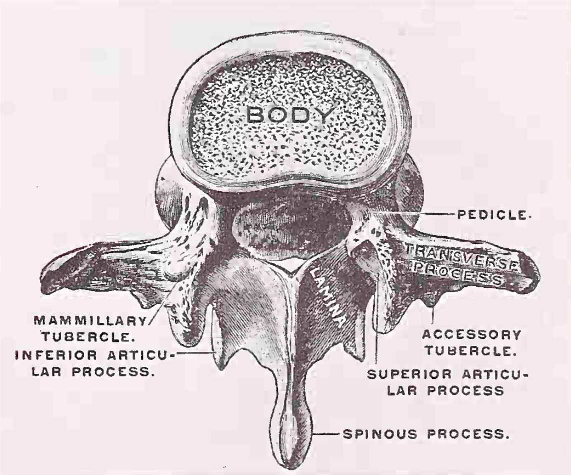
5-6

5-6

Cervical Vertebra, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

A cervical vertebra viewed from above.

5-8


BODY
PEDICLE.
TRANSVERSE PROCESS
LAMINA
MAMMILLARY TUBERCLE.
INFERIOR ARTICULAR PROCESS.
ACCESSORY TUBERCLE.
SUPERIOR ARTICULAR PROCESS
SPINOUS PROCESS.

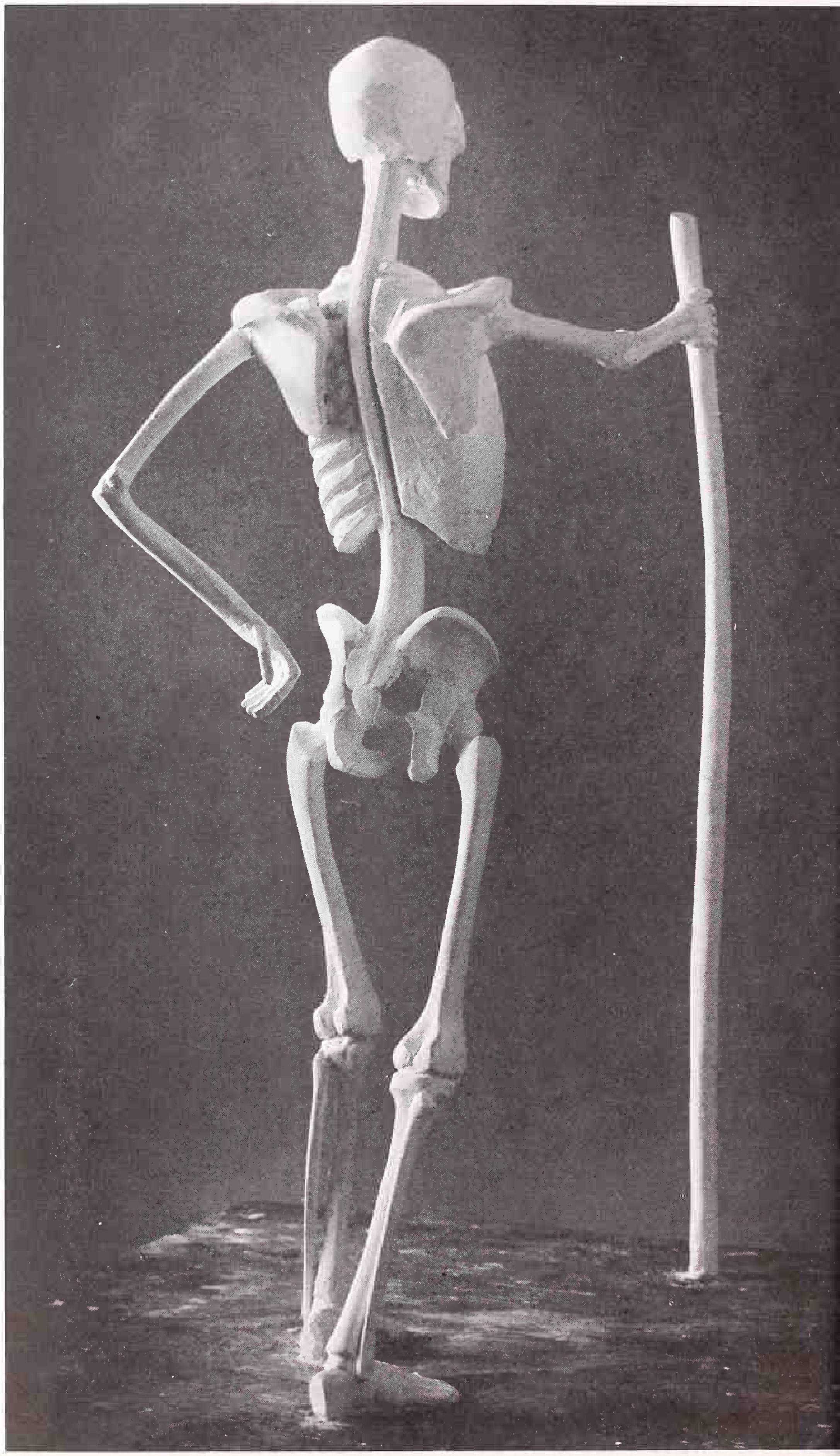
5-9

Plaster Skeleton and Staff (based on a figure from the study for The Battle of Ostia by Raphael) by Morgan Gilpatrick. (Photograph by David Abrams.)

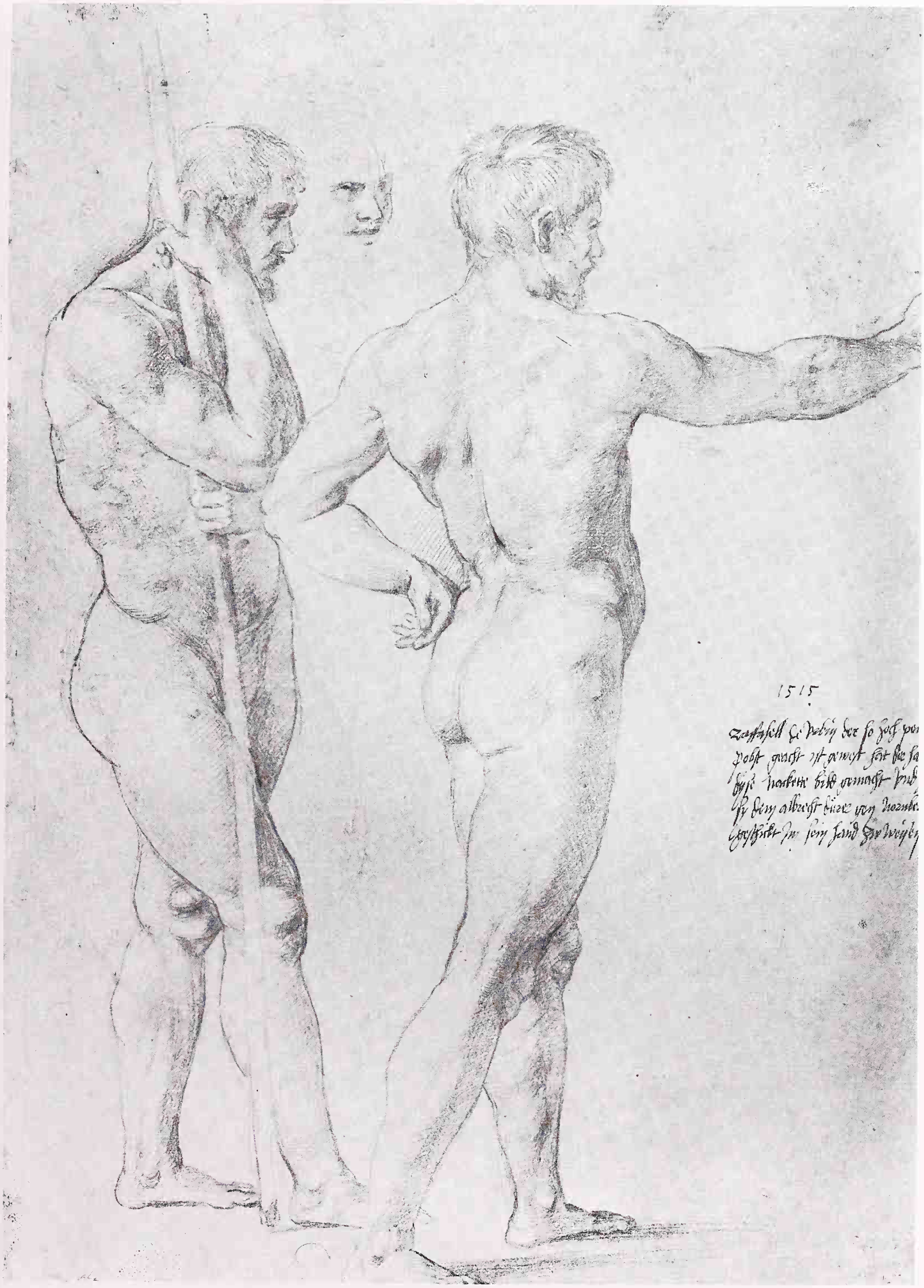
This plaster model of the skeleton by a young artist demonstrates an essential selectivity in the investigation of anatomical information. Only significant relationships in each bony form have been stressed. Variations of texture and minor sutures and irregularities have been integrated into the longer form. It is this kind of selectivity that permits retention of useful information.

5-10

Two Male Nudes (study for The Battle of Ostia) by Raphael. (Graphische Sammlung Albertina, Vienna.)



5-9


1515
Raffahell de Vrbin der so hoch pe
Bobst geacht ist gewest hat der ha
dyse nackette bild gemacht vnd
sy dem albrecht dürer gen Nornbe
geschickt Im sein hand zw weis

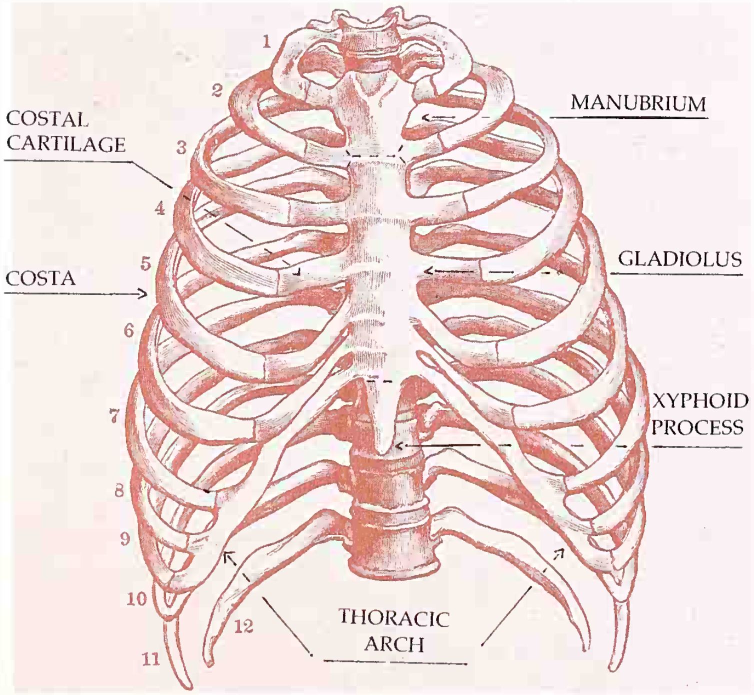
5-10

THE RIB CAGE

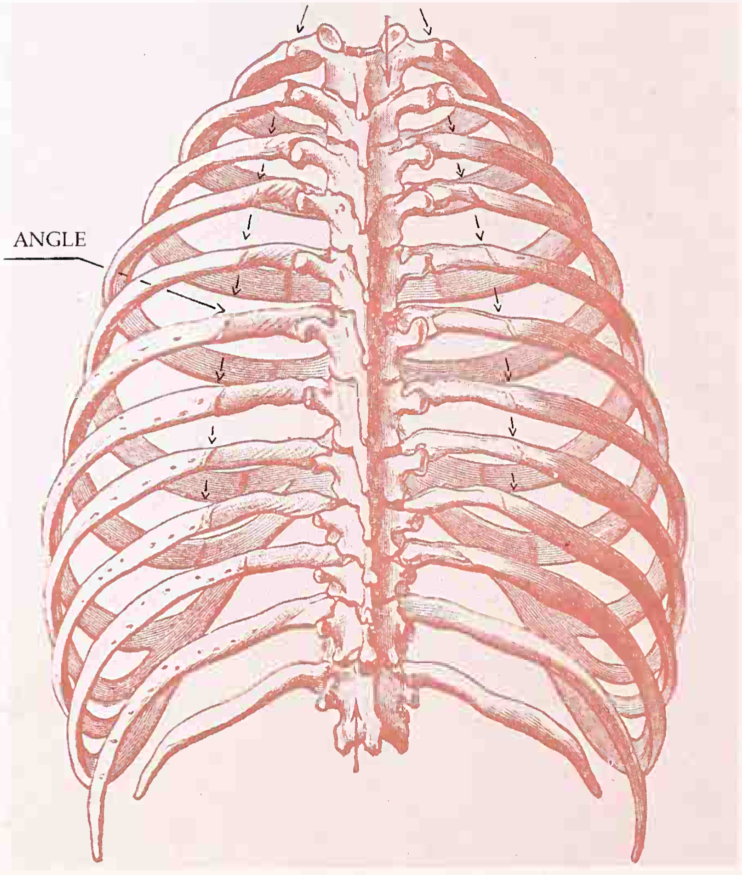
The rib cage [5-11, 5-12], the major skeletal frame for the volume of the upper torso, is to an extent hidden within the shoulder girdle and the strong musculature of the back and chest. This intimate overlapping of the ribs by the shoulder girdle makes it difficult to separate and identify the individual forms.

The form of the thorax (rib cage) from the rear is expressed indirectly through the scapula overlaying the volume beneath. The full form—the space-filling, three-dimensional capacity of the torso—is primarily fixed by this ribbed, egglike or keg-shaped framework [5-11, 5-12]. Some idea of the dimension of the rib cage may be inferred from external facts. The diameter of the base of the neck behind the clavicle approximates the size of the opening of the first rib. Comparing this dimension with the enclosing curves of the ribs on each side of the upper torso beneath the chest will offer some understanding of the shape of this form [5-13, 5-14].

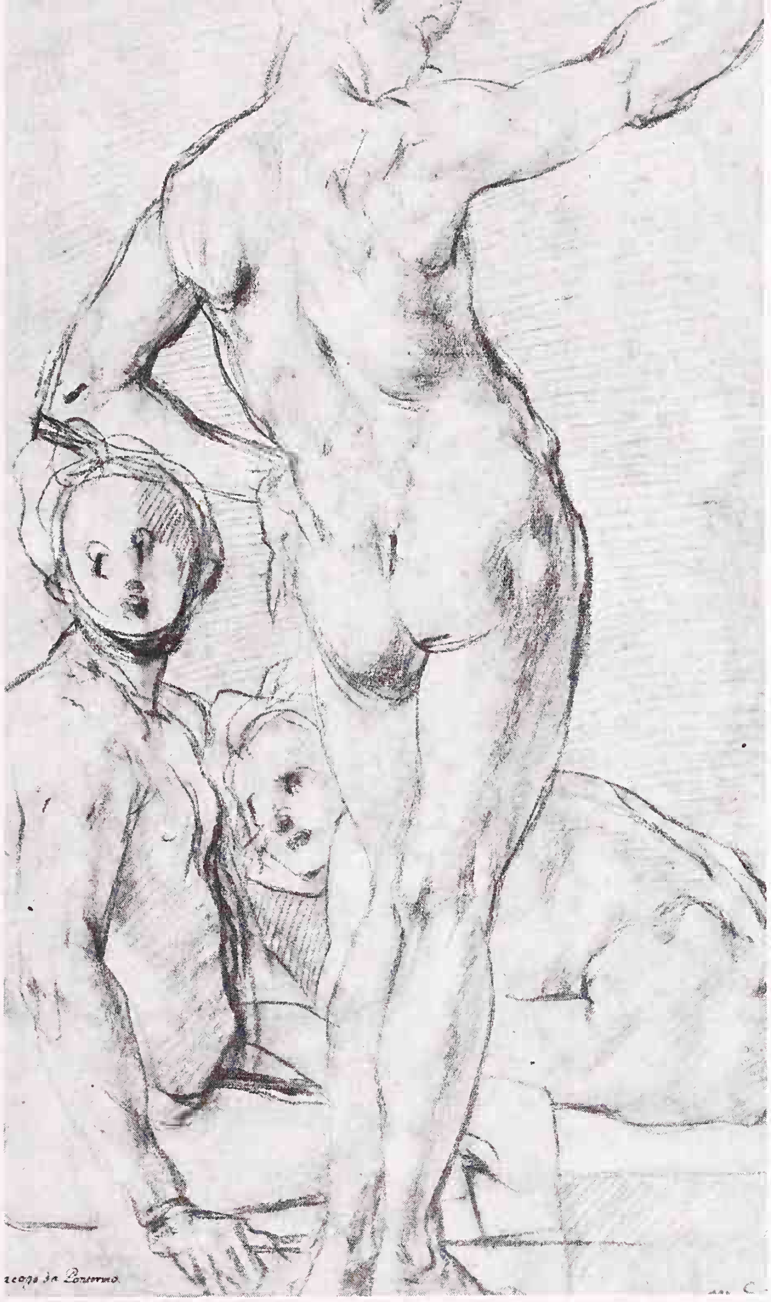
In the rib cage, the relationship of the sternum (breastbone) to the lower dorsal section of the spinal column is important to the axis of the torso. They are roughly parallel. The breastbone is like a bony necktie on the chest into which the cartilages of the ribs insert [5-14]. The sternum is formed of three firmly joined units. The top unit, the manubrium, is like the knot of the tie, and its upper surface locates the pit of the neck. The gladiolus is the blade-shaped body below this form. The small lower extension is called the xyphoid process [5-14].



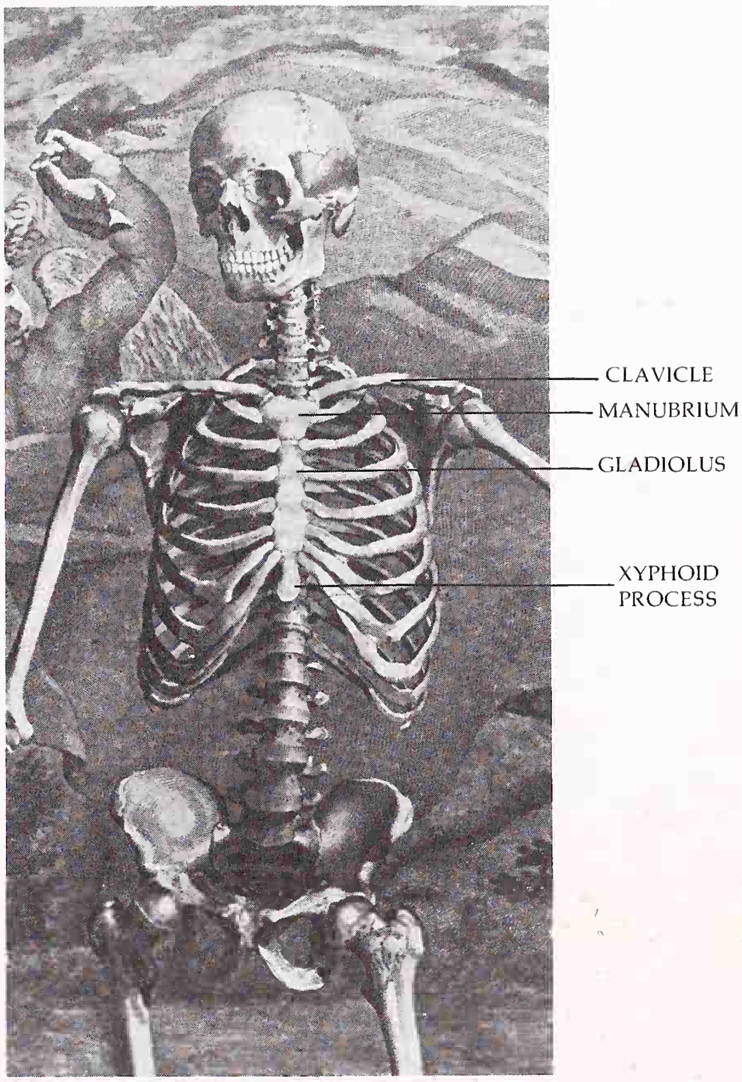
5-11



5-12



5-13



5-14

5-11
The Thorax: Front View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The cartilage that forms the thoracic arch is an identifiable limit to the form of the rib cage. Aligned with the breastbone (sternum) and the vertical curvature on either side from the fifth to the tenth rib, the influence of ribs on the external form is significant.

5-12
Thorax: Back View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The vertical alignment of the angles of the ribs contribute to the bulging fullness of the form on either side of the vertebral column. This curvature extends downward into the lower erector spinae muscles attaching into the sacrum and pelvic bone.

5-13

Standing Male Nude Seen from the Back, and Two Seated Nudes (red chalk) by Jacopo da Pontormo. (Courtesy: The Pierpont Morgan Library.)

The egglike form of the rib cage and the triangular frame of the scapula may be clearly distinguished in this drawing. (Compare this with the drawing by Raphael [5-10].) When the arm is raised, the scapula swings away from the spine. Guidelines mark its location. (Compare the position of the scapula here with the illustration by Julian Fau in the next chapter [6-11].)

5-14
Detail of the Rib Cage and Pelvis, from The Skeleton: Front View, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

In this illustration, the breastbone (sternum) and its three parts can be seen. The topmost unit, the manubrium, forms the pit of the neck and is triangular in shape. The middle unit, the gladiolus, has a long, wedgelike shape. The xyphoid process, the third unit, is suspended below like a small, rounded pendant.

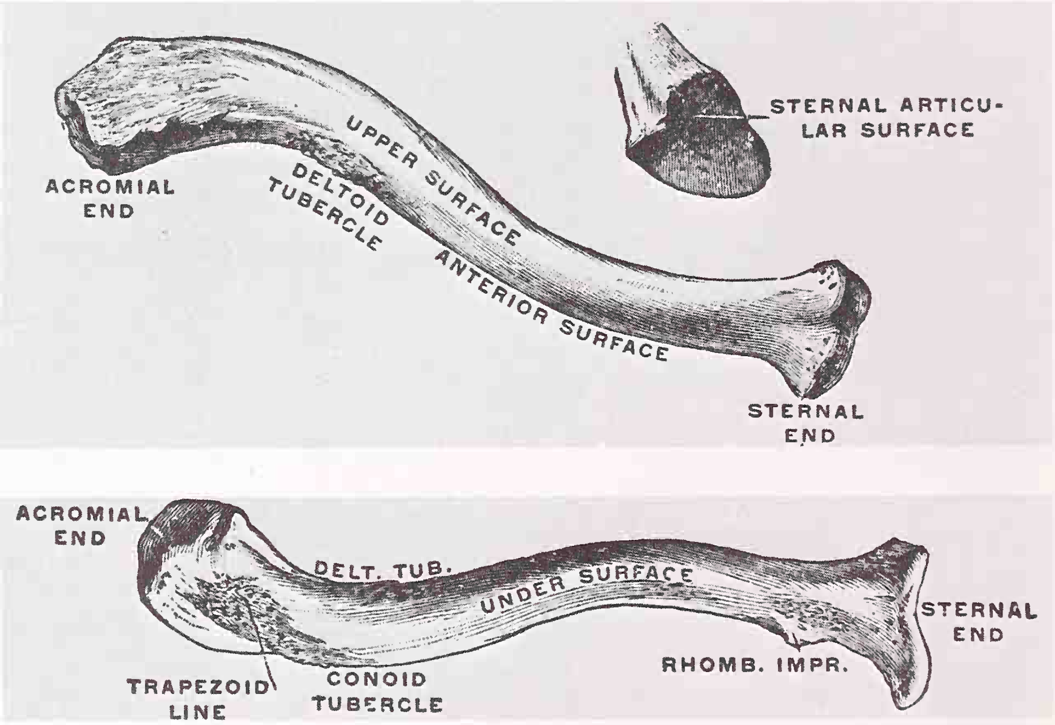
THE SHOULDER GIRDLE

The shoulder girdle is a loose framework of two bones, the clavicle (collarbone) and the scapula (shoulder blade), joined at the outer shoulder. These two bones enclose the upper part of the rib cage, front and back. The scapula glides smoothly over the ribs in the upper back, pivoting at its acromion process (shoulder articulation) against the outer extremity of the clavicle. This is its only direct contact with another bone. The clavicles, in turn, articulate in front with the upper unit of the sternum (the manubrium). From this single articular connection at the pit of the neck, the shoulder girdle enjoys wide movement [5-15, 5-16].

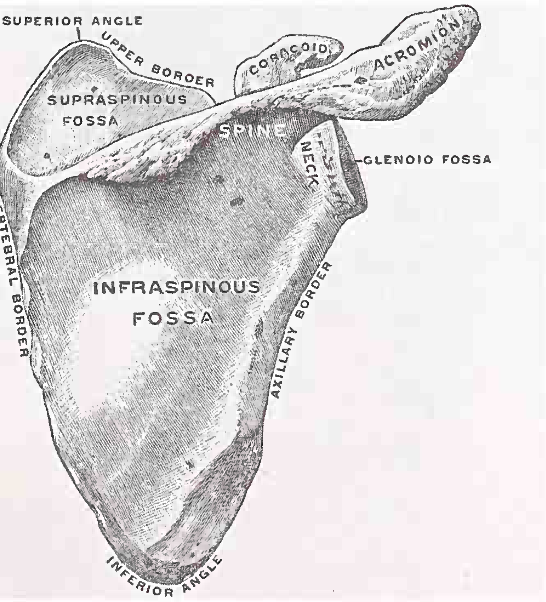
Since the bone of the upper arm (humerus) articulates with the glenoid cavity of the scapula, this added shoulder flexibility contributes to the great range of movement in the arm. (This relationship should be reviewed when studying the arm as part of the upper extremity [5-17, 5-18].)

5-15
The Right Clavicle, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

5-16
Dorsal View of Right Scapula, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)


STERNAL ARTICULAR SURFACE
ACROMIAL END
UPPER SURFACE
DELTOID TUBERCLE
ANTERIOR SURFACE
STERNAL END
ACROMIAL END
DELT. TUB.
UNDER SURFACE
STERNAL END
RHOMB. IMPR.
TRAPEZOID LINE
CONOID TUBERCLE

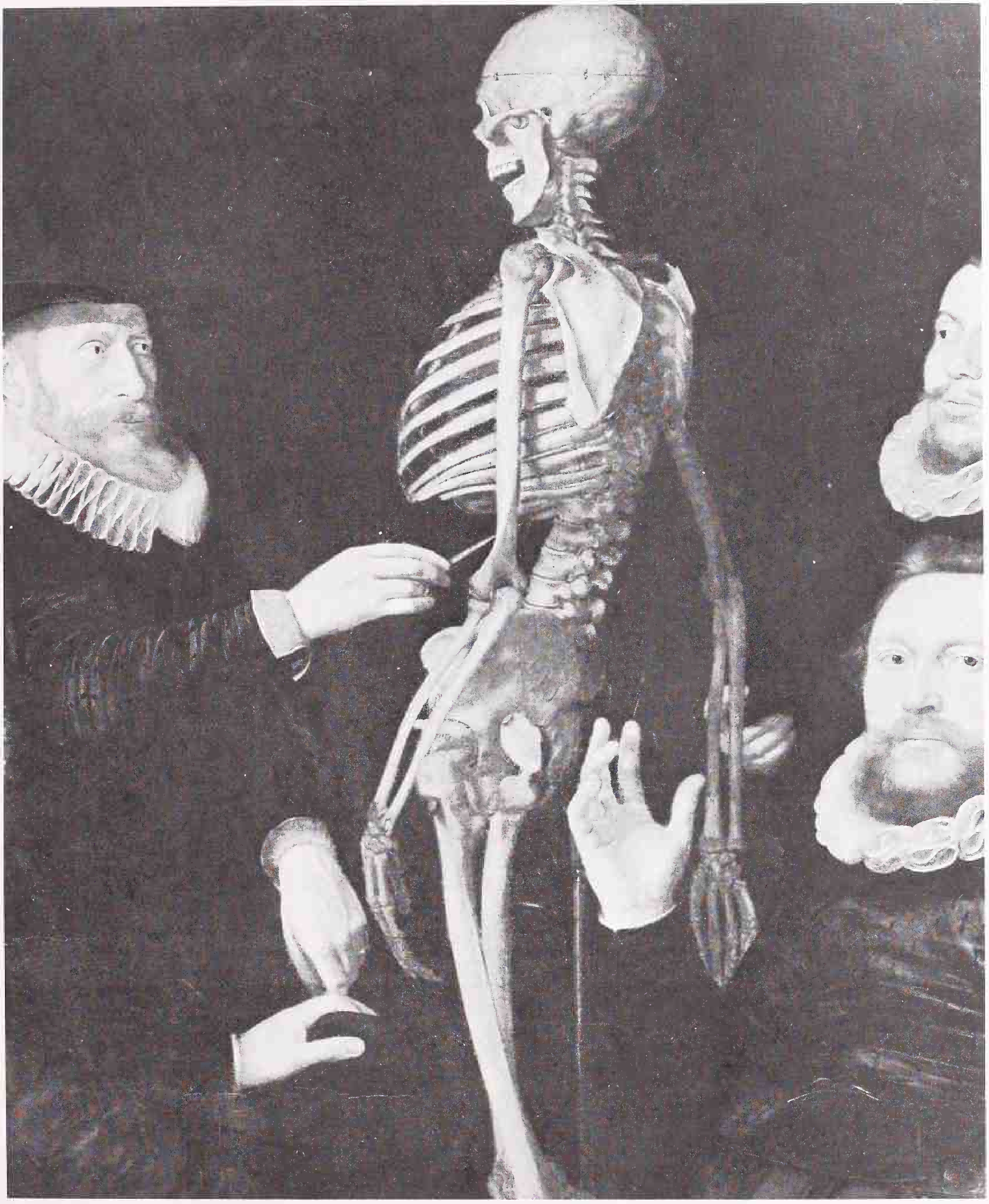
5-15


SUPERIOR ANGLE
UPPER BORDER
CORACOID
ACROMION
SUPRASPINOUS FOSSA
SPINE
NECK
GLENOID FOSSA
RTEBRAL BORDER
INFRASPINOUS FOSSA
AXILLARY BORDER
INFERIOR ANGLE

5-16

5-17
Detail from The Anatomy Lesson of Dr. Egbertsz (oil on canvas) by Thomas de Kayser. (Rijksmuseum, Amsterdam.)

The rib cage, similar to a rounded keg, is the dominant volume in the torso. It is enclosed by the scapula in the upper back. (Compare this with the sketch by Pontormo [5-13] and with the skeleton in the lithograph by Raffet in the next chapter [6-1].) The anatomist, in this detail, is pointing to the disklike body of a vertebra.



5-17

PLANES OF THE UPPER TORSO

While most body forms exhibit a challenge by their complexity, some present a problem by their apparent simplicity. The chest plane within the torso is a case in point [5-23, 5-24]. It is formed largely by the pectoralis major muscle spreading out on both sides of the breastbone (sternum) and the inner part of the clavicle. It inserts into the bicipital ridge of the humerus bone at the shoulder, stretching uniformly over the ribs. The unseasoned draftsman may be disarmed by the unadorned chest expanse. The chest plane is frequently ignored—treated as a nonexistent surface area—probably because it is framed by a number of visually more intriguing forms. Seen from the front, the chest plane has no obvious outer contour limit. It is enclosed: (1) on top by the clavicle and neck (and above and behind by the trapezius, upper back); (2) on each side by the shoulders; (3) below by the rib cage (in the female, by the breasts).

This relationship often leaves the mistaken impression that the chest plane has no clear identity. It is therefore incumbent on the observant student to measure the frame of the chest with great care, to momentarily isolate its shape and clearly note its distinctive form. Failure to consider this surface area carefully will result in a cottony, flaccid, unsupported structure and an unconvincing central surface contact for the more obvious and easily seen adjacent forms.

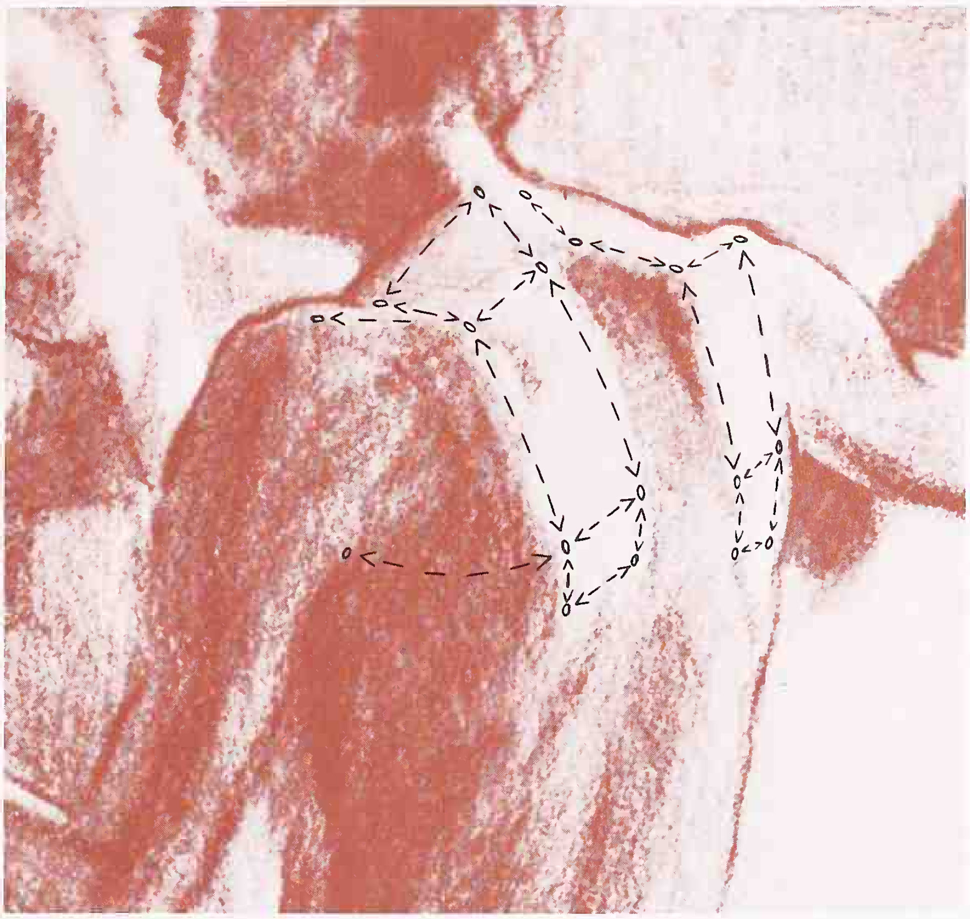
The chest plane is markedly altered when the arms are raised, the pectoral (chest) muscle being pulled into the form of the deltoid (shoulder), and the two seeming to become one muscle form. This can be seen in the Leonardo drawing in the preceding chapter [4-10].

When the arms are relaxed and hanging, the outer third of the curve of the clavicle marks a surface change that corresponds to the origin of the deltoid (shoulder). In this position, the chest plane in relation to the shoulders is like the center panel of a three-paneled screen with the shoulders as the outer projecting panels [5-24]. The thickness of the pectoral muscle and its insertion beyond the ribs into the humerus bone of the arm somewhat flattens the plane of the chest over the curvature of the upper ribs, but the larger egglike fullness of the rib cage should not be forgotten or ignored.

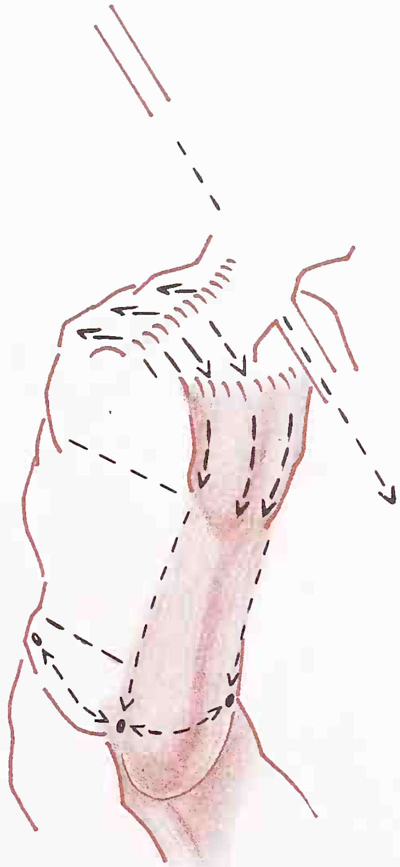
In the female form, the breast is divided by the pectoral muscle at its outer limit, a part attaching into the side of the rib cage below the armpit, and the major portion forming an appendage over the lower chest. Again the curvature of the ribs cannot be overlooked. In a reclining pose the breasts are flattened and fall to each side of the arched rib form. This opposing movement of the breasts, down on each side and away from the sternum, is a far more subtle relationship in the standing figure.

The pit of the neck (manubrium), bordering above the chest, is a very useful point of reference [5-23]. It is the hub for forms radiating out in many directions: (1) from the larynx to the hyoid bone vertically above; (2) from the sterno-cleido-mastoid muscles moving diagonally upward to behind the ears (inserting at the mastoid process); (3) from the clavicles moving outward, right and left, to the shoulders; (4) from the sternum projecting down to the high point of the thoracic arch.

The Del Sarto study [5-20], a figure seen from a three-quarter view, reveals the thickness and dimension of the upper torso from the upper back over the shoulder blade and the space between trapezius and clavicle. The two planes are pitched to an apex at the height of the trapezius. From the spine of the scapula in the back, up to the limit of the trapezius, down to the clavicle in front, two inclined planes "roof over" the top of the torso and convey its thickness, front to back [5-19]. (Note how the staff, in contact with the clavicle, emphasizes the forward top plane.)



5-18



5-19

5-18

Detail from Model and Mirror by the author. (Photograph by Kalman Zabarsky.)

The bony triangular frame of the scapula (and the spine of the scapula) encloses the top shoulder plane, identifying the thickness of the upper torso from the back. The planes over the upper rib cage are primarily formed by the scapula in relation to the spine. Compare this with illustration 5-10. (See illustration 5-58 for the complete drawing.)

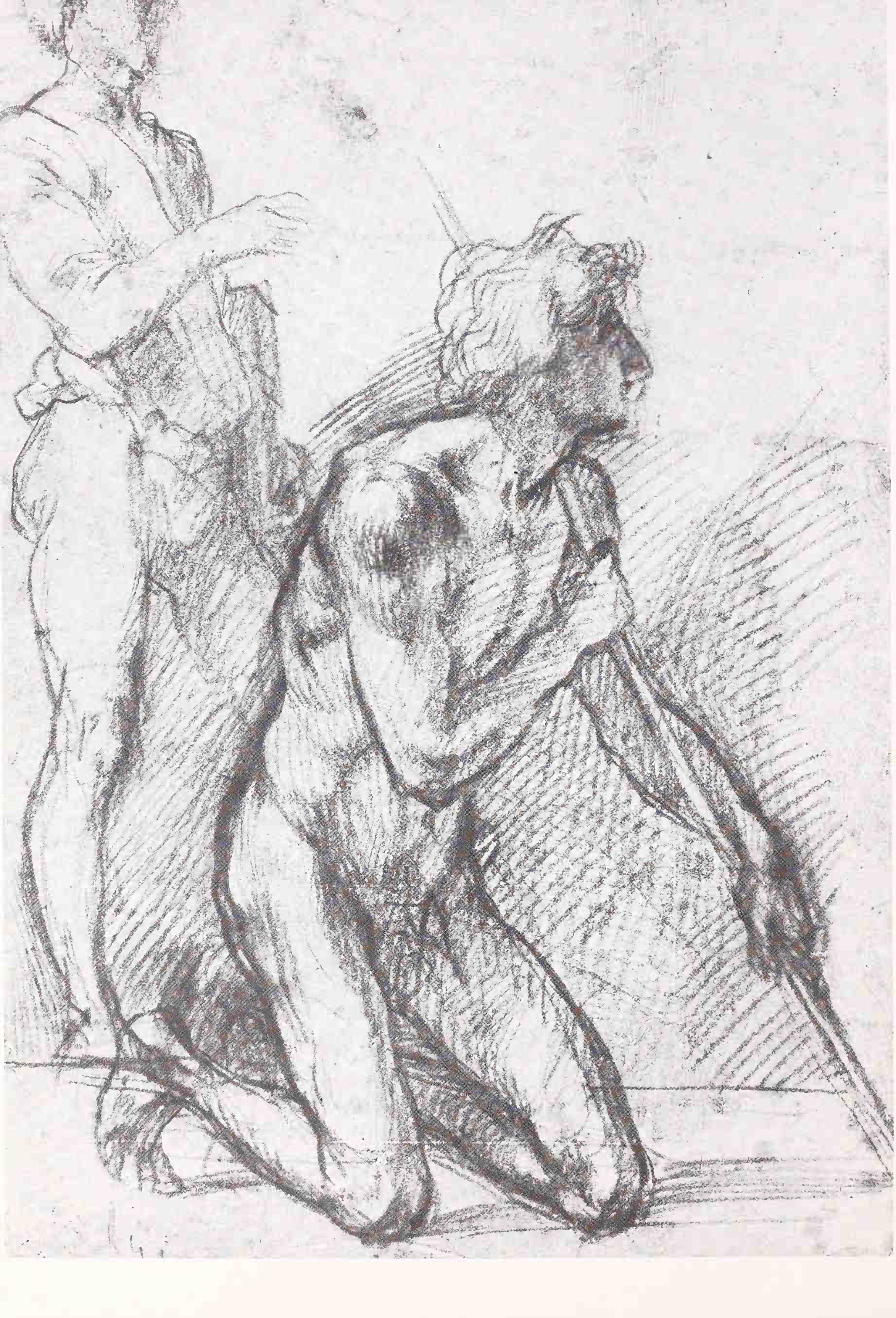
5-19

Diagram of the Planes in Study of a Kneeling Figure.

This diagram is based on the study by Andrea Del Sarto [5-20]. The two planes of the shoulder and the upper back, from the collarbone to the spine of the scapula "roof over" the top of the torso and convey its thickness. Both planes meet at the height of the trapezius muscle. These planes are related to the architecture of the side and front of the figure and extend downward into the hip structure.

The shoulder blades are two thin, triangular frames clearly visible on each side of the upper back. Each has a strong projecting ridge called the spine of the scapula. Seen from the back, the spine of the scapula comes more directly into play as a significant limit to the top surface of the shoulder [5-9, 5-10]. The two opposing angles (created by the two scapula spines) establish strong directions which enclose the volume of the upper torso.

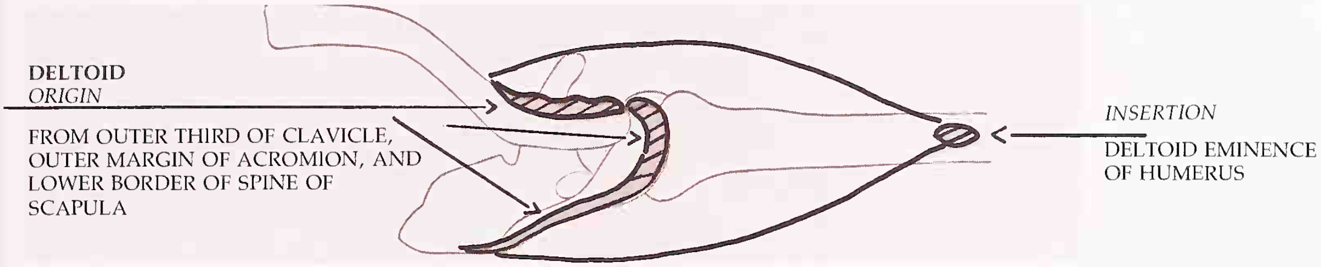
The torso seen from the side or three-quarter view requires special care in its organization. The individual rib, set in place, has a diagonal direction down from its vertebral attachment around to the front of the figure [5-11]. Its curve and its pronounced marking on the slender model can confuse and hide the overall order of planes on the front and side of the body. On a muscular individual this is further complicated by the obvious plaited effect of the serratus magnus muscle with the external oblique, creating an interlocking zigzag pattern that offers an irresistible temptation to lovers of detail [5-34]. Drawn without understanding and out of context, this area can obliterate all sense of form and unity in the torso.

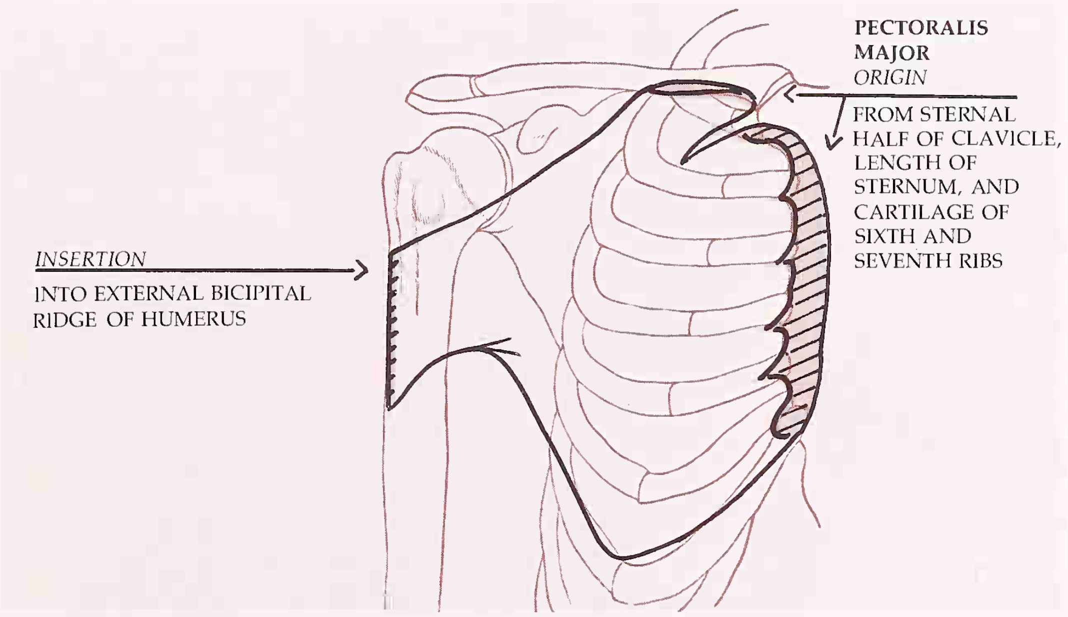


5-20

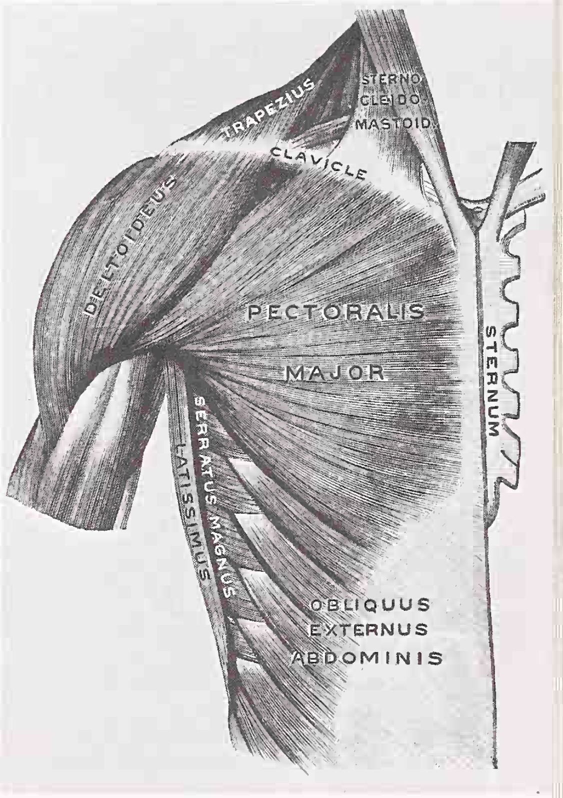
The serratus magnus is a broad, flat (segmented) muscle originating on the side of the rib cage from the eight upper ribs and converging up and under the scapula to its inner border (near the backbone) [5-33, 5-34, 5-35].

The external oblique originates from the lower border of the eight lower ribs joining against the five lower segments of the serratus magnus. The larger curving plane of the rib cage on the side of the torso must be preserved while these muscle segments are drawn and integrated. The external oblique at its insertion on the outer crest of the pelvis forms the overhanging fullness of the flank pad.


DELTOID
ORIGIN
FROM OUTER THIRD OF CLAVICLE, OUTER MARGIN OF ACROMION, AND LOWER BORDER OF SPINE OF SCAPULA
INSERTION
DELTOID EMINENCE OF HUMERUS


PECTORALIS MAJOR
ORIGIN
FROM STERNAL HALF OF CLAVICLE, LENGTH OF STERNUM, AND CARTILAGE OF SIXTH AND SEVENTH RIBS
INSERTION
INTO EXTERNAL BICIPITAL RIDGE OF HUMERUS

5-21


TRAPEZIUS
STERNO CLEIDO MASTOID
CLAVICLE
DELTOIDEUS
PECTORALIS
MAJOR
STERNUM
SERRATUS MAGNUS
LATISSIMUS
OBLIQUUS
EXTERNUS
ABDOMINIS

5-22

5-20

Study of a Kneeling Figure by Andrea Del Sarto. (Courtesy: Trustees of the British Museum.)

The relationship of the collarbone to the shoulder blade identifies the thickness of the torso—front to back. The pressure of the staff against the shoulder emphasizes the diagonal direction of the top front plane from the clavicle to the trapezius muscle. The plane from the trapezius to the spine of the scapula completes the thickness of the torso. (Compare this illustration with the sketches by Leonardo in the previous chapter [4-10].)

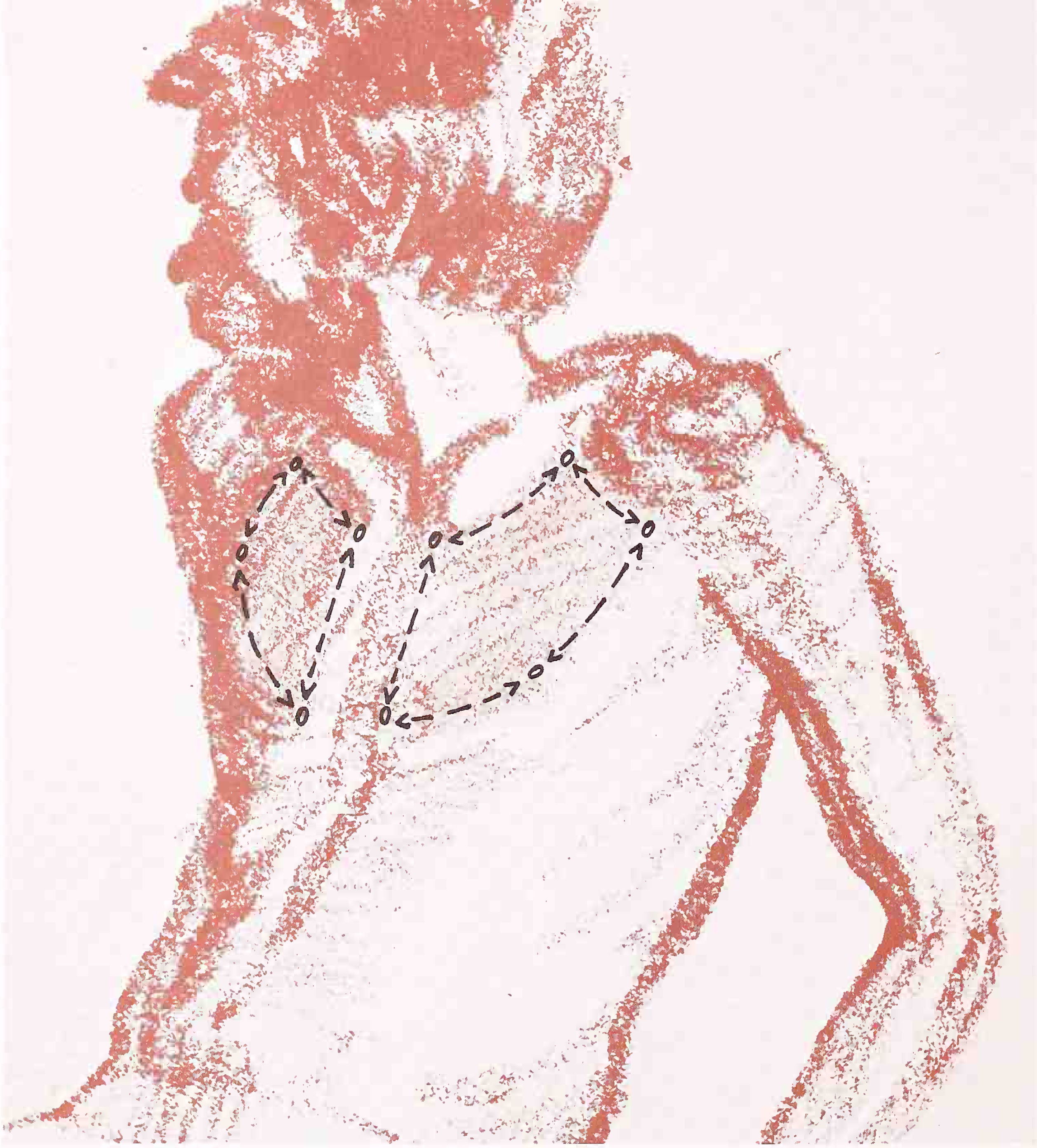
5-21

The Deltoid Muscle and Pectoralis Major Muscle. (Photograph by Iso Papo.)

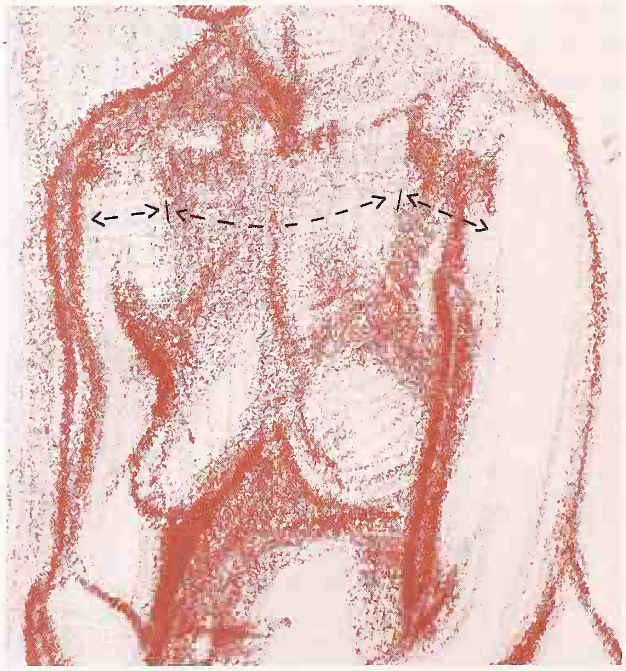
5-22

Muscles of the Chest and Shoulder: right side, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

Note the braided connection between the external oblique and the serratus magnus muscles. It is visible on the figure as a zigzag line.



5-23



5-24

5-23
Shoulders and Chest (crayon) by the author. (Photograph by Kalman Zabarsky.)

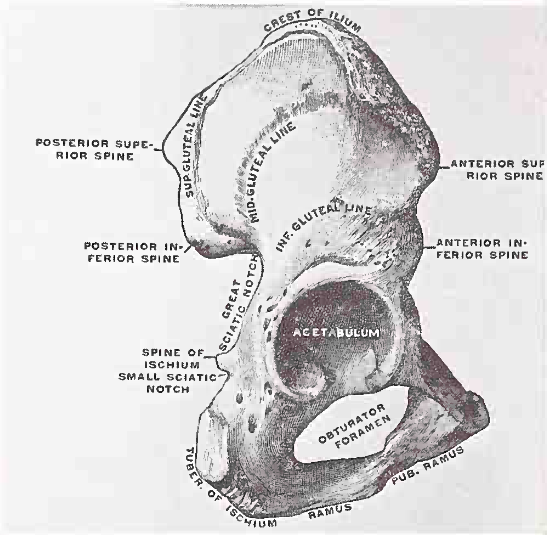
The chest plane, a relatively simple area, is frequently ignored in favor of more interesting adjacent forms. It should be carefully measured to hold in place the prominent forms joining into it. (See illustration 4-10, the studies by Leonardo, for the muscles of the chest.)

5-24
Detail of Shoulders and Chest from Figure Study (crayon) by the author. (Photograph by Kalman Zabarsky.)

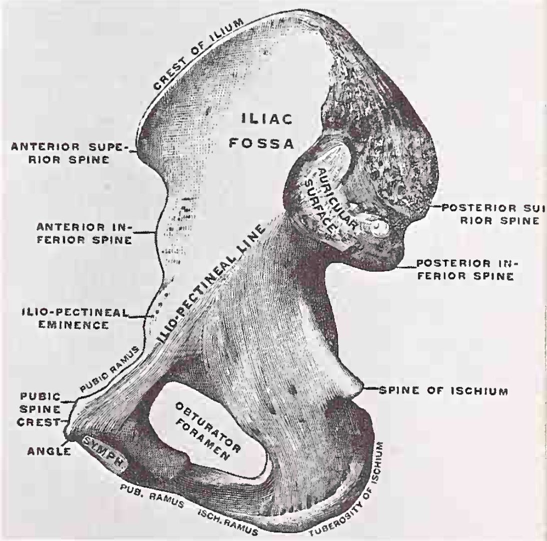
In the upper torso, the chest plane is like the center panel of a three-paneled screen. When the arms hang limp beside a relaxed torso, the shoulders project forward like two outer panels.

THE PELVIS AND ABDOMEN

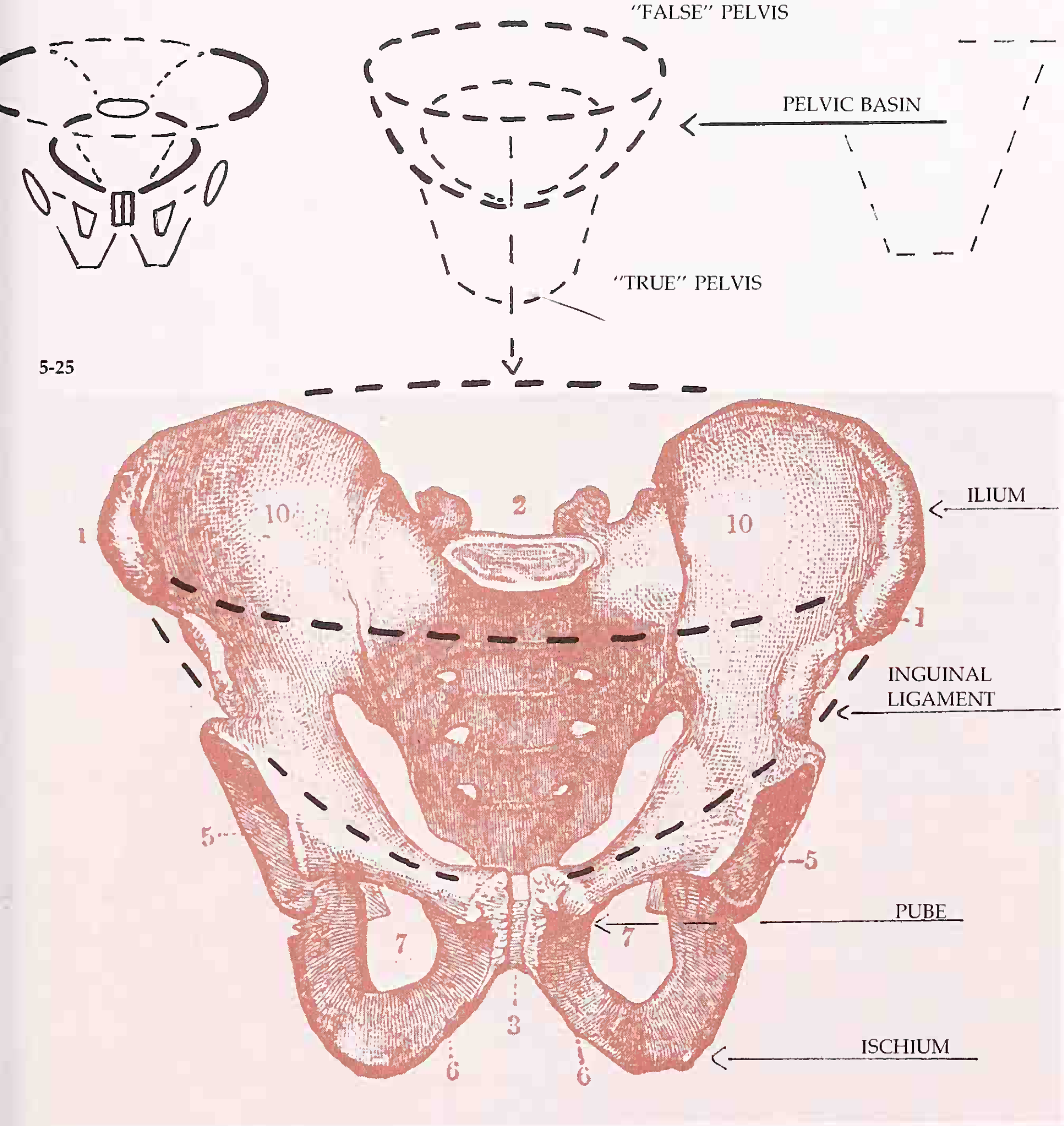
The composite form of three bones known as the pelvis is puzzling in its apparent irregularity [5-25, 5-26, 5-27]. Although the two flaring sides, joining the sacrum, are called the "nameless bone" (os innominatum), having no similarity to any known object, the form as a whole may be given some order and description. The lower portion, made up of the triangular sacrum, the ischial tuberosities, and the pubic arch, forms a small, perforated basketlike enclosure (the true pelvis). Above are the two fan-shaped wings with a thick, curving ridge (iliac crest) flaring out from an inner rim (pectineal line) and forming the back part of a larger basin (the false pelvis) [5-25]. Behind the pubic area are located the cuplike sockets for the articular head of the femur. The thickened lower ischial tuberosities support the body when it is in a seated posture.


CREST OF ILIUM
POSTERIOR SUPE-RIOR SPINE
SUP. GLUTEAL LINE
MID-GLUTEAL LINE
ANTERIOR SUF RIOR SPINE
INF. GLUTEAL LINE
POSTERIOR IN-FERIOR SPINE
ANTERIOR IN-FERIOR SPINE
GREAT SCIATIC NOTCH
ACETABULUM
SPINE OF ISCHIUM
SMALL SCIATIC NOTCH
OBTURATOR FORAMEN
TUBER. OF ISCHIUM
PUB. RAMUS
RAMUS

5-26


CREST OF ILIUM
ILIAC FOSSA
ANTERIOR SUPE-RIOR SPINE
AURICULAR SURFACE
POSTERIOR SUI RIOR SPINE
ANTERIOR IN-FERIOR SPINE
POSTERIOR IN-FERIOR SPINE
ILIO-PECTINEAL LINE
ILIO-PECTINEAL EMINENCE
PUBIC RAMUS
SPINE OF ISCHIUM
PUBIC SPINE CREST
OBTURATOR FORAMEN
ANGLE
SYMPH.
PUB. RAMUS
ISCH. RAMUS
TUBEROSITY OF ISCHIUM

5-27


"FALSE" PELVIS
PELVIC BASIN
"TRUE" PELVIS
5-25
1
10
2
10
ILIUM
1
INGUINAL LIGAMENT
5
5
PUBE
7
7
3
ISCHIUM
6
6

5-25
The Pelvis: Front, from Artistic Anatomy by Mathias Duval. (Photograph by Iso Papo.)

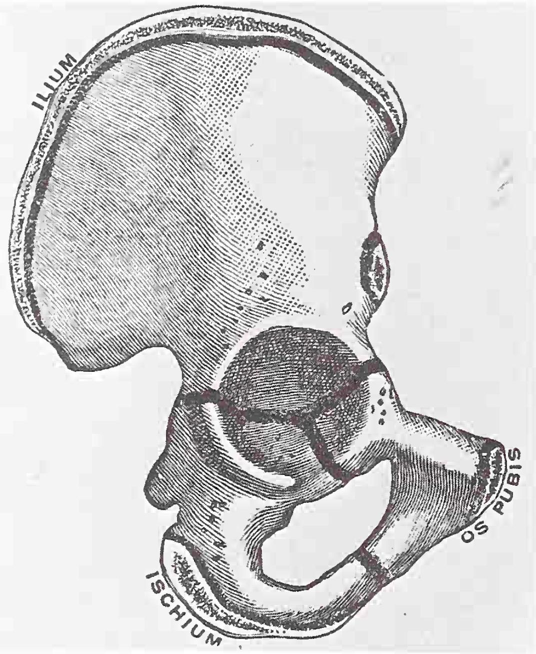
The two parts of the pelvis, the os innominata (hip bones), are unusual in shape and difficult to visualize in drawing. Some fundamental order may be projected, if the pelvis is seen as a segment of two perforated basins, one resting above the other (see diagram), the fan-shaped ilium forming part of the upper basin and the sacrum, ischia, and pubic bones forming the lower, smaller basin.

5-26
Os Innominatum: Outer Surface, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

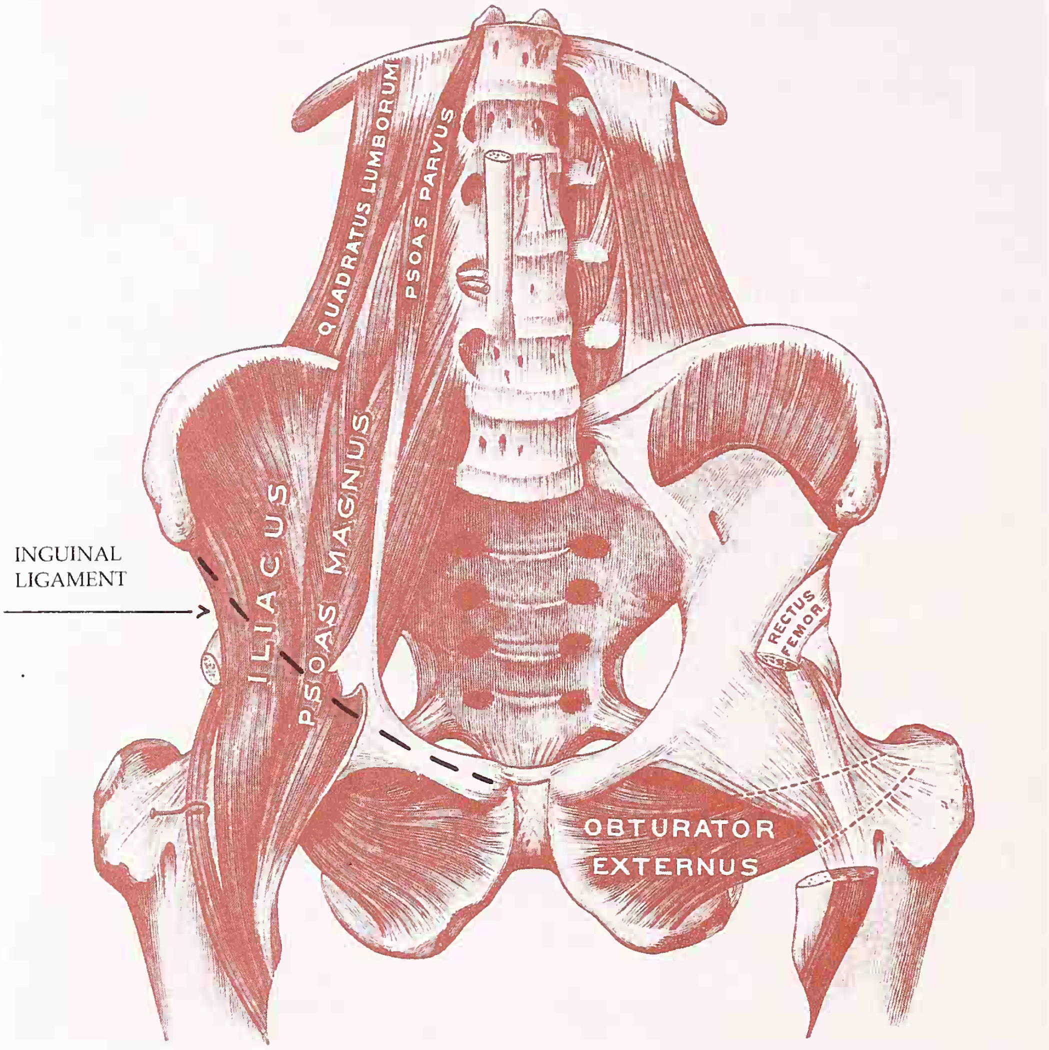
The outer surface of the os innominatum (hip bone) is directly identifiable on the surface of the figure along the crest of the ilium, the anterior superior spine, and the posterior superior spine. The acetabulum is the socket for the rounded head of the femur, the long bone of the thigh.

5-27
The Os Innominatum: Inner Surface, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The ilio-pectineal line is the division between the "true" pelvis (below) and the "false" pelvis (above). The two hip bones, joined to the sacrum, form the pelvis.



5-28



5-29

5-28

The Os Innominatum, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

At birth, the three portions of the hip, the ilium, ischium, and the pubes are separate. With growth, the union of these three parts occurs within the acetabulum (hip socket) to become a single bone form.

5-29

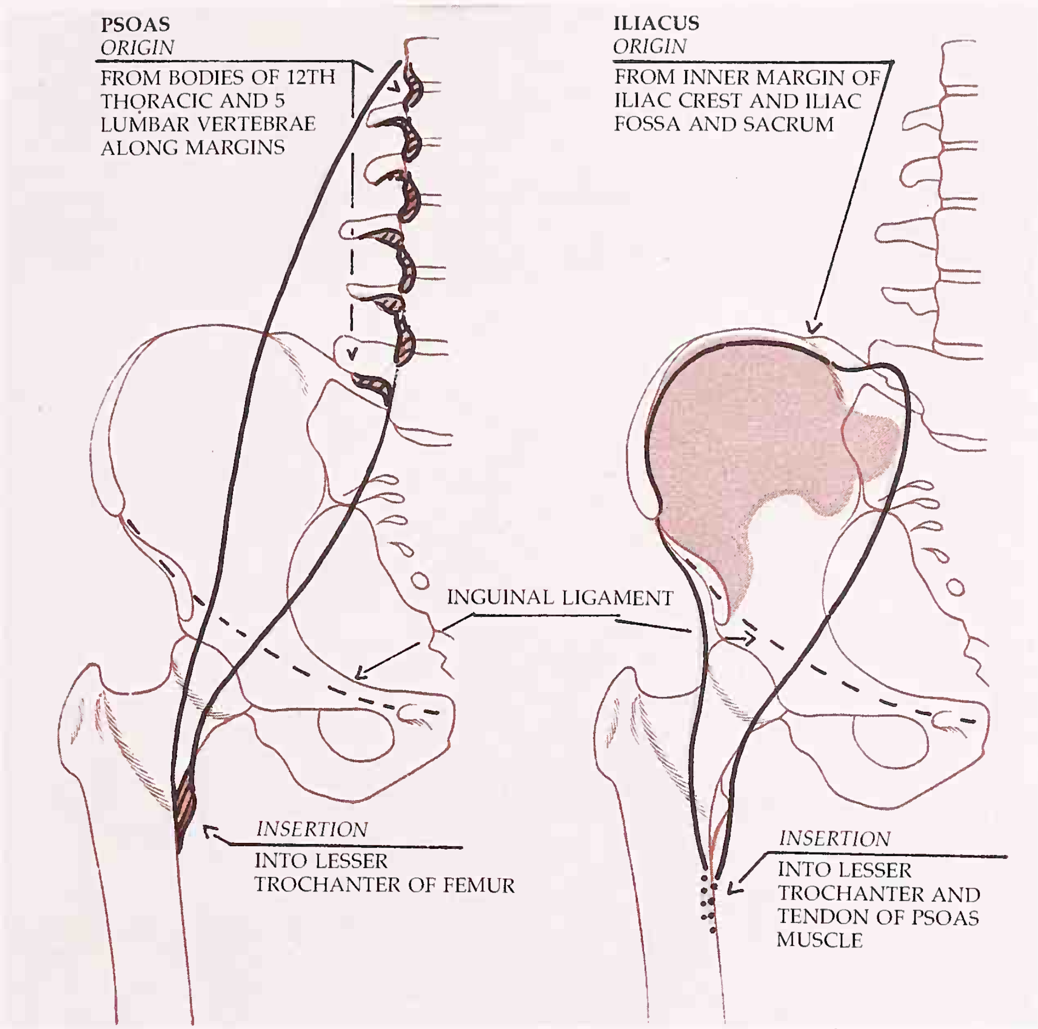
Psoas and Iliacus Muscles, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

Only the lower portions of the psoas and iliacus are visible below the inguinal ligament, indicated by the dotted line.

The pelvis initially may be conceived as two joined basins, the larger above, with much of its enclosing surface removed. Above the iliac crest of the pelvis is the muscular fullness of the lower portion of the external oblique muscle forming the flank pad [5-32]. Fleshing out the form of the flank pad are the transversalis and internal oblique muscles beneath the external oblique. The upper, curved bony ridge of the pelvis (iliac crest) is set in and under and should not be confused with this fleshy form above. Below the iliac crest, on the side, are the tensor fasciae latae and gluteus medius. Originating from the rear iliac crest and sacrum is the large, padded gluteus maximus muscle.

The abdominal muscle (rectus abdominus) [5-33] stretches like a tent over the lower front of the torso, attached to bone at the arch of the ribs above, and the reverse pelvic arch below (emphasized by Poupart's ligament). Its mid-area, as a volume, is formed by the pressure of internal organs (intestines, bladder, etc.). As a consequence of this limited peripheral contact with bone, it too can be radically altered in form by the movement of the spine (and ribs and pelvis).

On either side of the median line (linea alba and navel) the abdominal mass contains a frontal plane parallel to the frontality of the figure. This plane turns diagonally back on both sides of the torso into the external oblique, like a three-sided screen angled away from the viewer [5-39, 5-40]. The form is somewhat rounded below and joins at the pubes. The rectus abdominus is segmented by tendons known as transverse lines. Care should be taken not to overemphasize these transverse divisions. They can obscure the three enclosing vertical planes of this form [5-40, 5-41].


PSOAS
ORIGIN
FROM BODIES OF 12TH THORACIC AND 5 LUMBAR VERTEBRAE ALONG MARGINS
ILIACUS
ORIGIN
FROM INNER MARGIN OF ILIAC CREST AND ILIAC FOSSA AND SACRUM
INGUINAL LIGAMENT
INSERTION
INTO LESSER TROCHANTER OF FEMUR
INSERTION
INTO LESSER TROCHANTER AND TENDON OF PSOAS MUSCLE

5-30

5-30

Diagram of the Psoas and Iliacus Muscles.

If the thigh is fixed these muscles flex the torso at the hip joint. (Both muscles, below the inguinal ligament, are visible on surface form.)

5-31

The Transversalis Muscle, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

This is the deepest of the three muscles of the "flank pad." The muscle fibers run horizontally.

5-32

The External Oblique Muscle, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

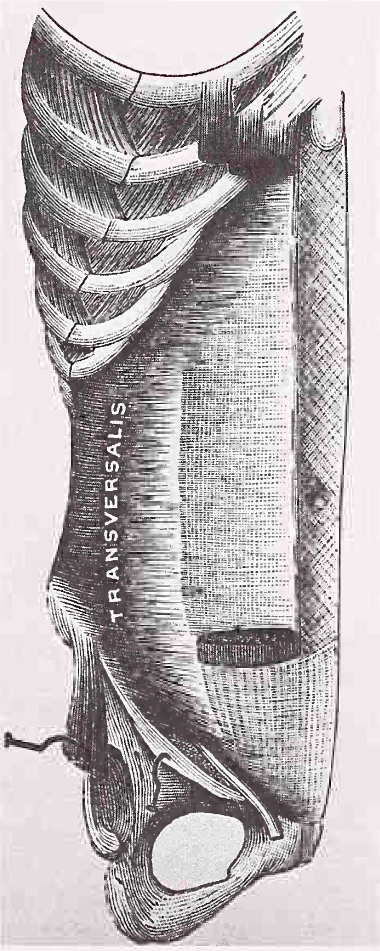
The external oblique muscles draw the ribs down and forward. Both together compress the abdomen and bend the body forward. Acting individually, each bends the trunk sideways.

5-33

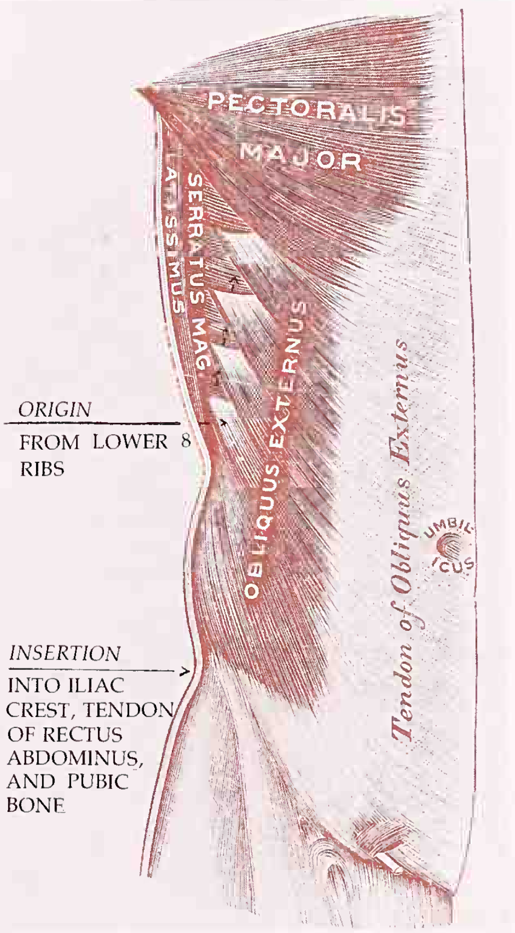
The Internal Oblique Muscle and Rectus Abdominus Muscle, from the Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The action of the internal oblique is to flex the thorax on the pelvis, compress the abdomen, and stabilize the pelvis. The action of the rectus abdominus is to bend the spine and flex the thorax on the pelvis, to maintain erect posture, to compress the abdomen, and so on.

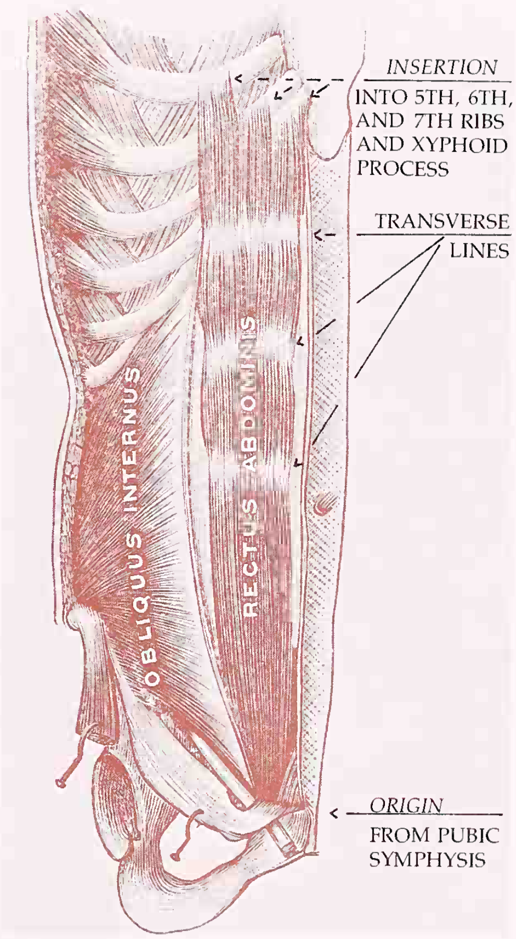
5-31

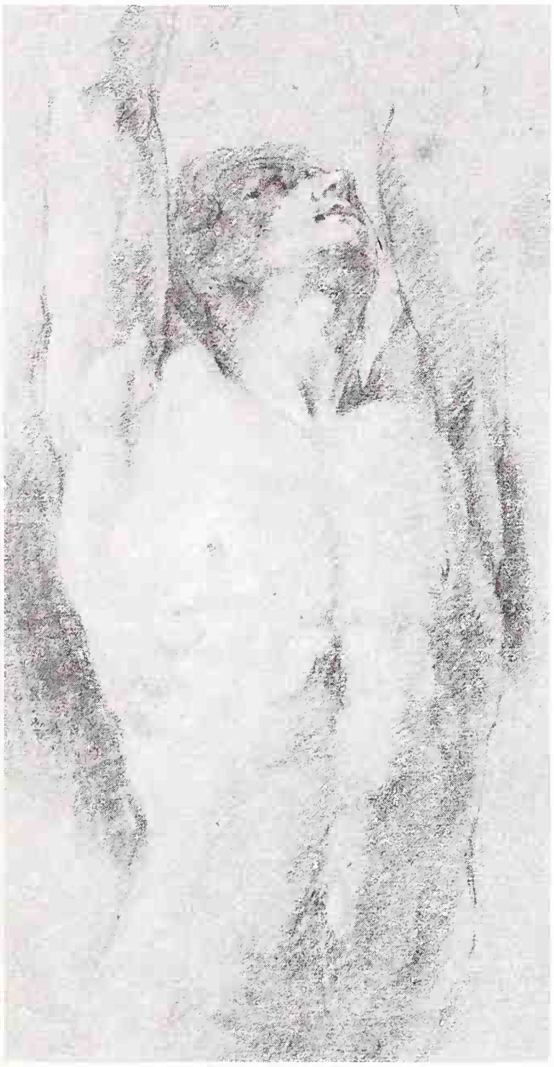

TRANSVERSALIS

5-32


PECTORALIS MAJOR
LATISSIMUS
SERRATUS MAG.
OBLIQUUS EXTERNUS
Tendon of Obliquus Externus
UMBILICUS
ORIGIN
FROM LOWER 8 RIBS
INSERTION
INTO ILIAC CREST, TENDON OF RECTUS ABDOMINUS, AND PUBIC BONE

5-33


INSERTION
INTO 5TH, 6TH, AND 7TH RIBS AND XYPHOID PROCESS
TRANSVERSE LINES
OBLIQUUS INTERNUS
RECTUS ABDOMINIS
ORIGIN
FROM PUBIC SYMPHYSIS

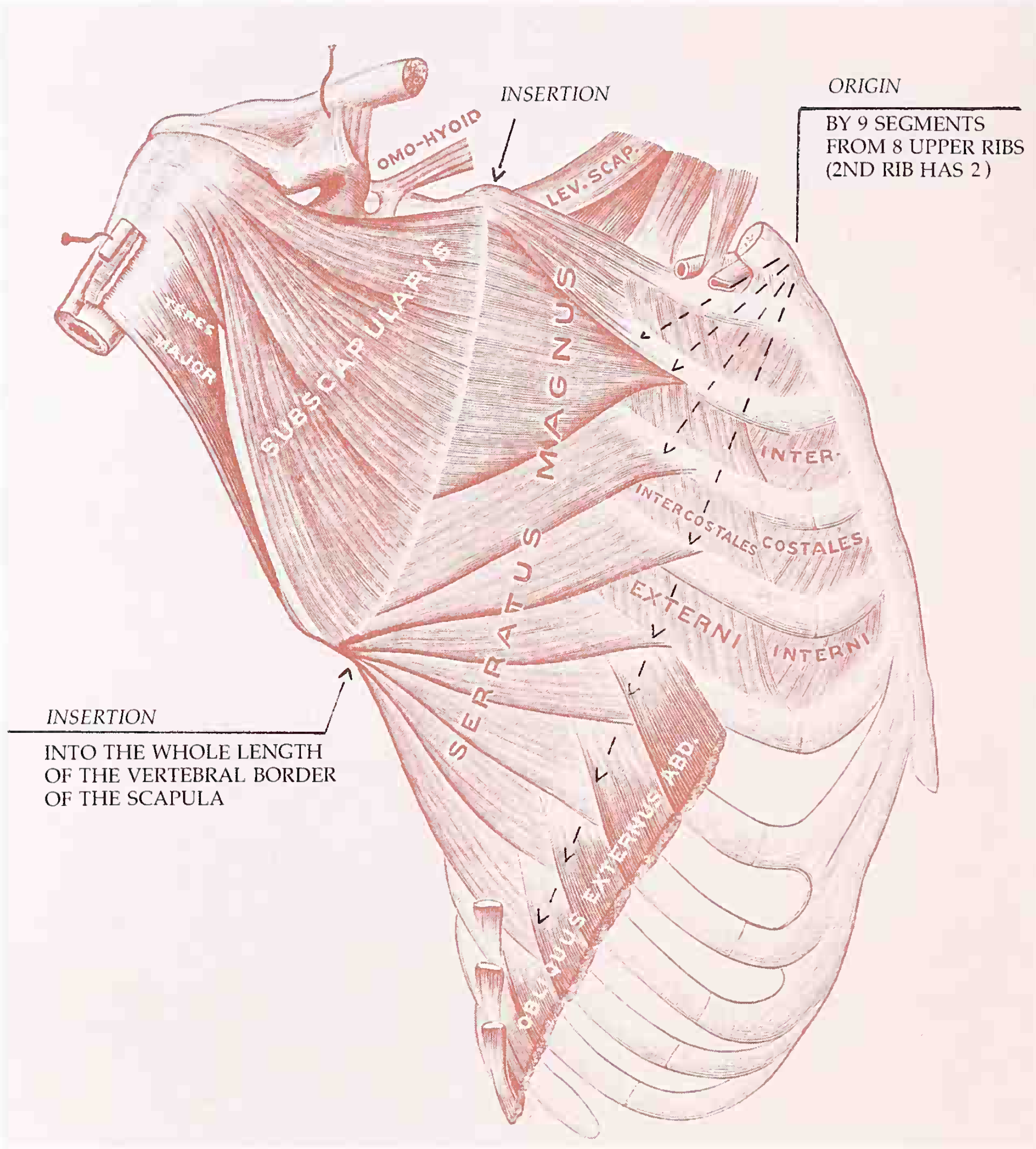


5-34

5-34

Study of a Man with Upraised Arms, **seventeenth century. (National Gallery of Scotland.)**

The interlocking of the serratus magnus and the external oblique muscles against the rib cage creates an often confusing zigzag pattern of shadow that should be seen in a larger context. This braided effect should be carefully organized in direction and tone so that it will tie into the larger planes of the torso.


INSERTION
ORIGIN
BY 9 SEGMENTS
FROM 8 UPPER RIBS
(2ND RIB HAS 2)
OMO-HYOID
LEV. SCAP.
TERES MAJOR
SUBSCAPULARIS
SERRATUS MAGNUS
INTER-
INTERCOSTALES
COSTALES
EXTERNI
INTERNI
OBLIQUUS EXTERNUS ABD.
INSERTION
INTO THE WHOLE LENGTH
OF THE VERTEBRAL BORDER
OF THE SCAPULA

5-35

5-35

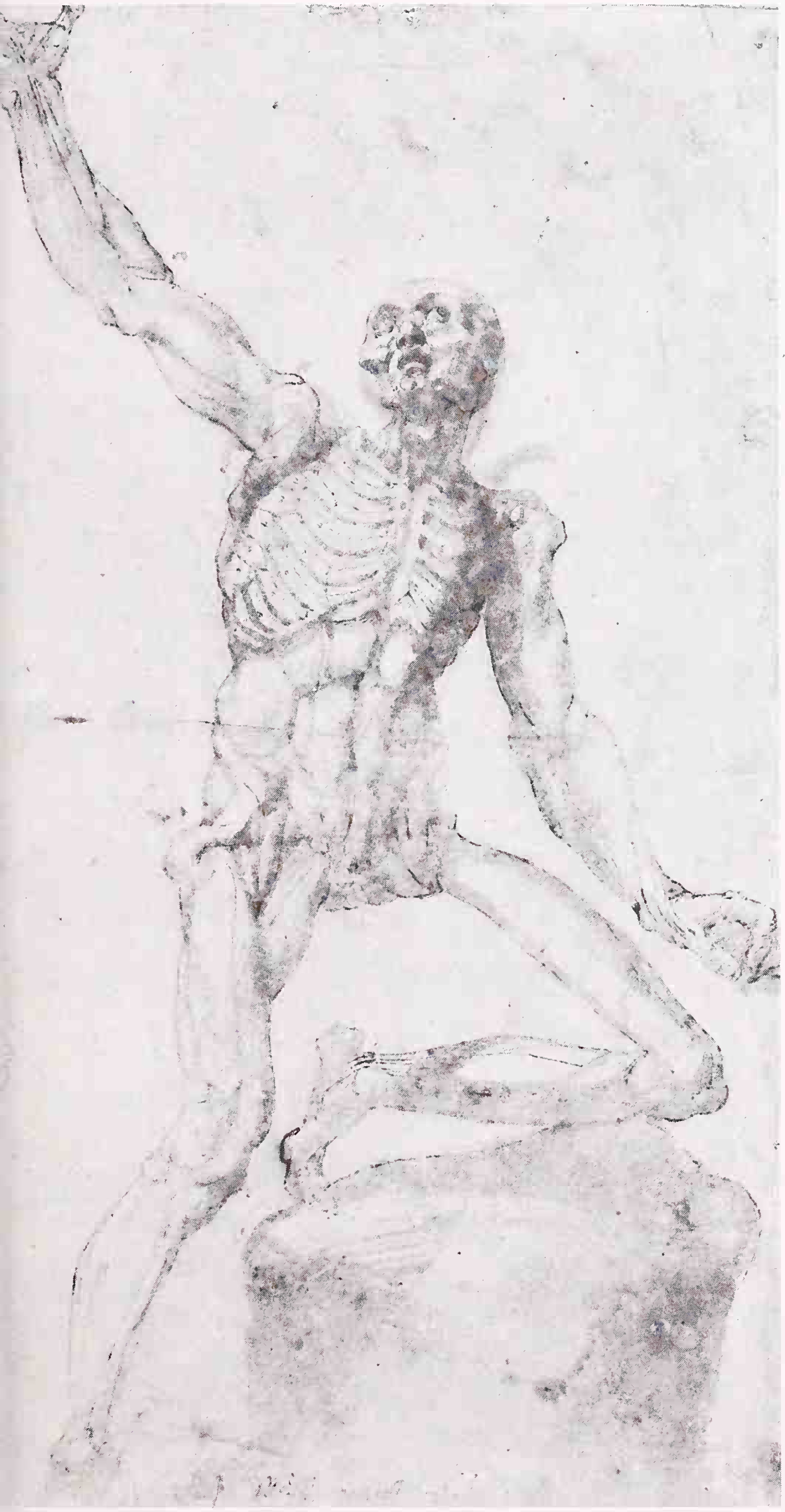
The Serratus Magnus Muscle, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The scapula has been turned out to reveal the insertion of the serratus magnus along the vertebral border. The serratus magnus is largely hidden by the scapula when it is in place against the ribs. It elevates the ribs and raises the glenoid fossa (outer scapula) upward.

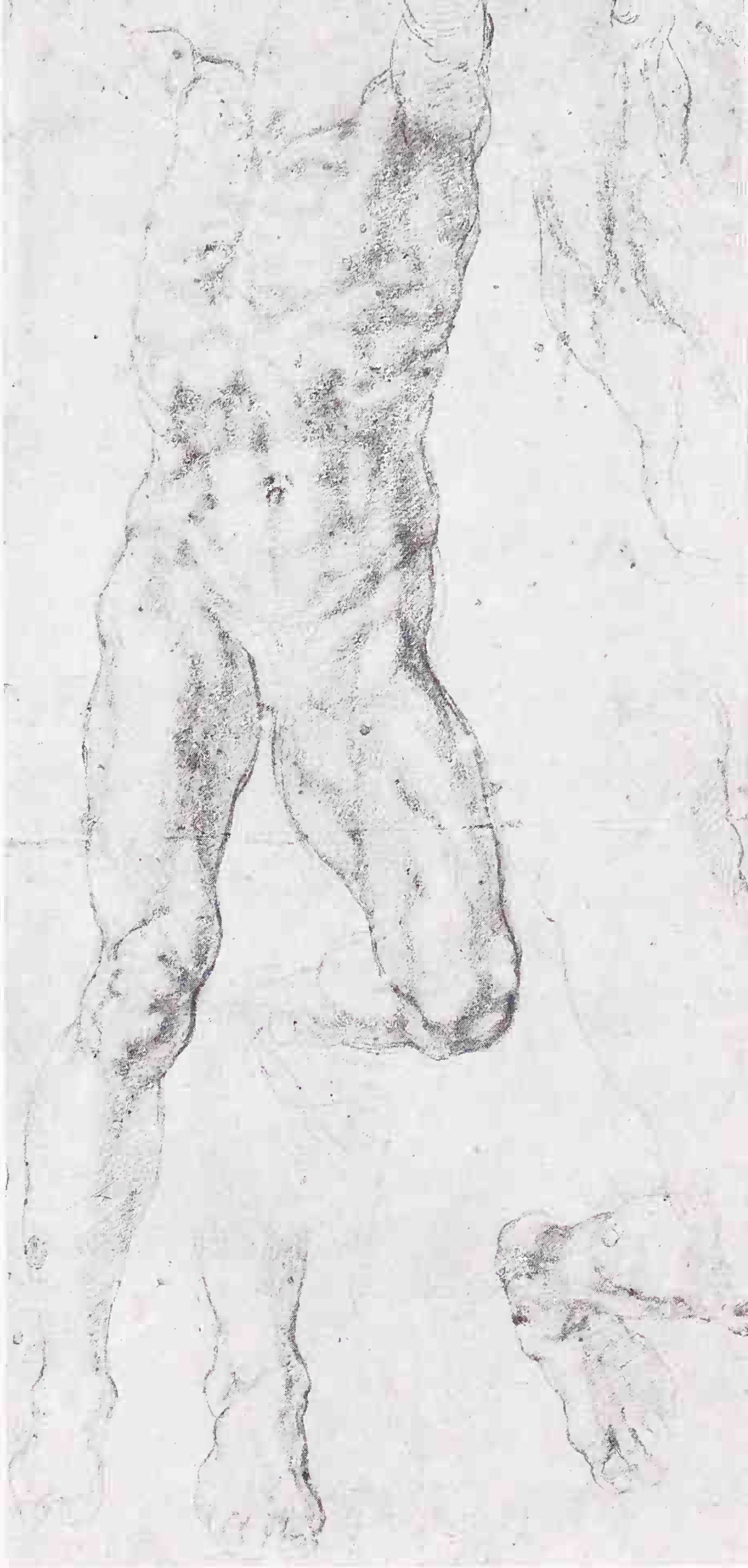
5-36

A Skeleton with One Leg Kneeling on a Rock by Rosso Fiorentino. (National Gallery of Scotland.)

This figure may be used as a partial dissection for the Michelangelo *Study for Haman* [5-37]. The rectus abdominus is pulled in under the ribs by the external oblique. (Contrast this with the drawing by Prud'hon [5-39]. This region, below the thoracic arch and above the pelvic girdle, occupied by abdominal muscle and flank pad, is an area free of bony support and therefore capable of wide modification as a volume. On either side of the median division are two parallel limits, which join the abdominal mass to the external oblique, projection above the crest of the hip bone. (Under the raised arm are segments of the serratus magnus.)



5-36

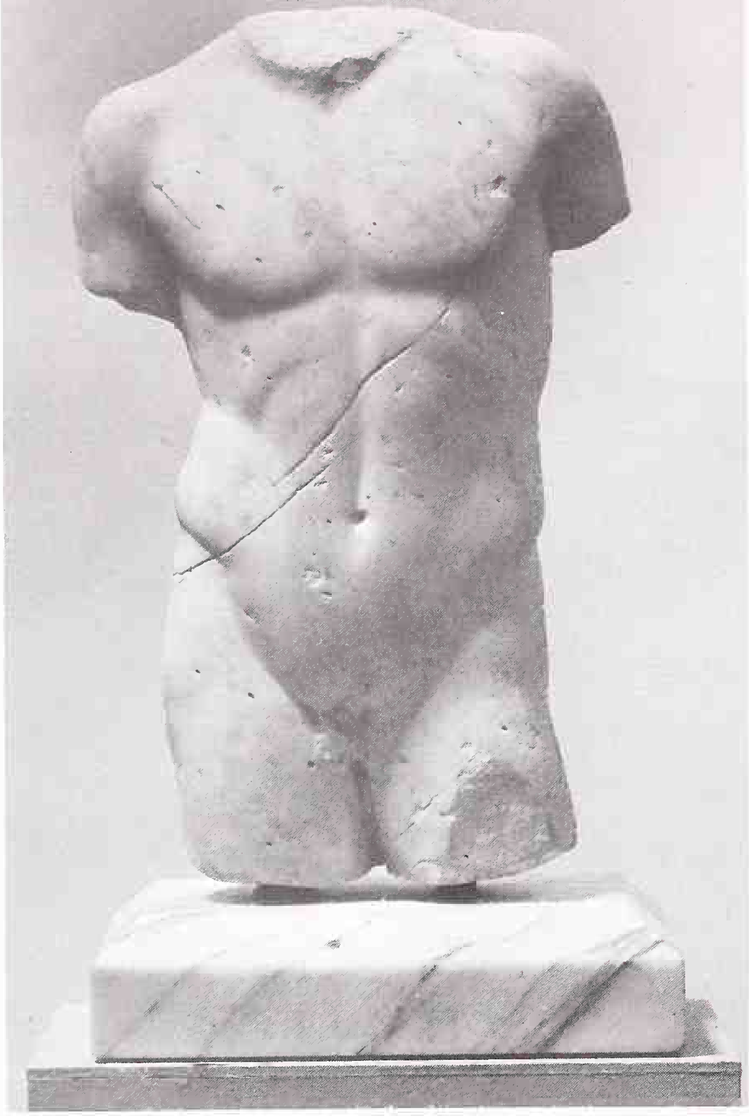


5-37

5-37

Study for the Figure of Haman by Michelangelo. (Courtesy: Trustees of the British Museum.)

In this extraordinary drawing the complicated tension of muscles and bones has been brilliantly integrated into fluent, powerful action functionally animating even the smallest forms, yet preserving structure and volume. The sharply foreshortened axial thrust through the raised arms and shoulders is opposed by the direct front view of the pelvis, giving a powerful twist to the torso. Within this spiral movement, contour and tonal complexity are organized to preserve large masses. The chest plane is confined by the tightened parallel shoulder and pectoral muscles, visible as a contour on the left and a shadow on the right. The front plane of the torso is framed by a long S-curved shadow running from the armpit at the right shoulder down to the hip. This long, interrupted shadow is repeated by the contour on the left side of the rib cage, and the movement continues within the torso, breaking into the pelvic cavity above the flank pad.

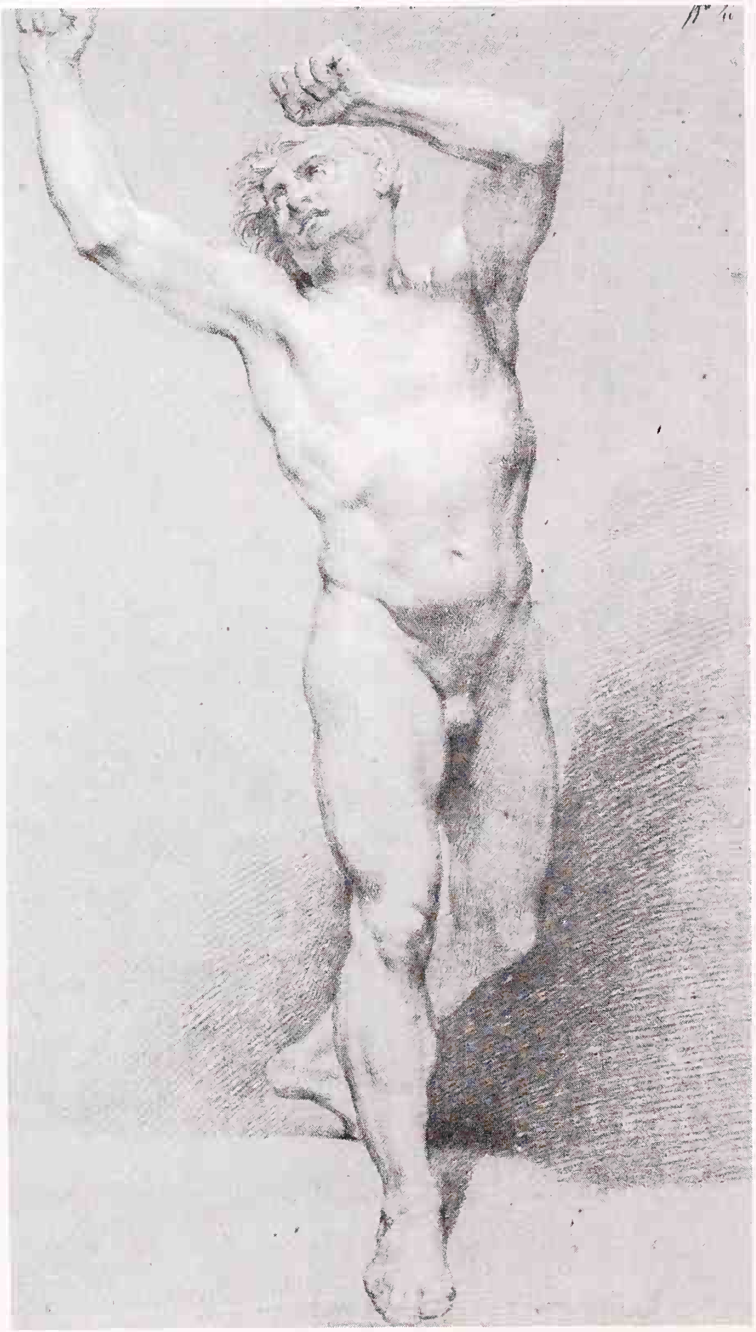


5-38

5-38

Male Torso (marble), Greco-Roman (first or second century A.D.; Warren Collection, Bowdoin College Museum of Art, Brunswick, Maine.)

The major muscles of the front of the torso: the pectoralis major, the rectus abdominus, and external oblique are clear in this Greco-Roman sculpture.

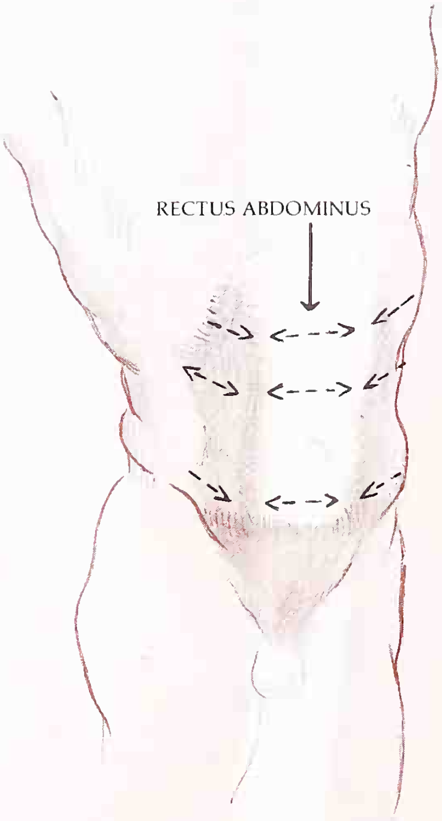


5-39

5-39

Study of a Male Nude with Arms Raised (drawing on toned paper, heightened with white) by Pierre-Paul Prud'hon. (Fogg Art Museum, Harvard University; Gift of Mr. and Mrs. Philip Hofer.)

The form of the abdomen is a variable mass of subtle curvature. The broad planes flow easily, one into the other. In the standing figure, the volume is made up of three planes forming a front and two sides enclosed below by the pelvic arch. This lower fullness, attaching into the pubic bone, completes the basinlike volume of the pelvis. In this drawing the form bulges foward. Compare it with illustrations 5-36 and 5-40.

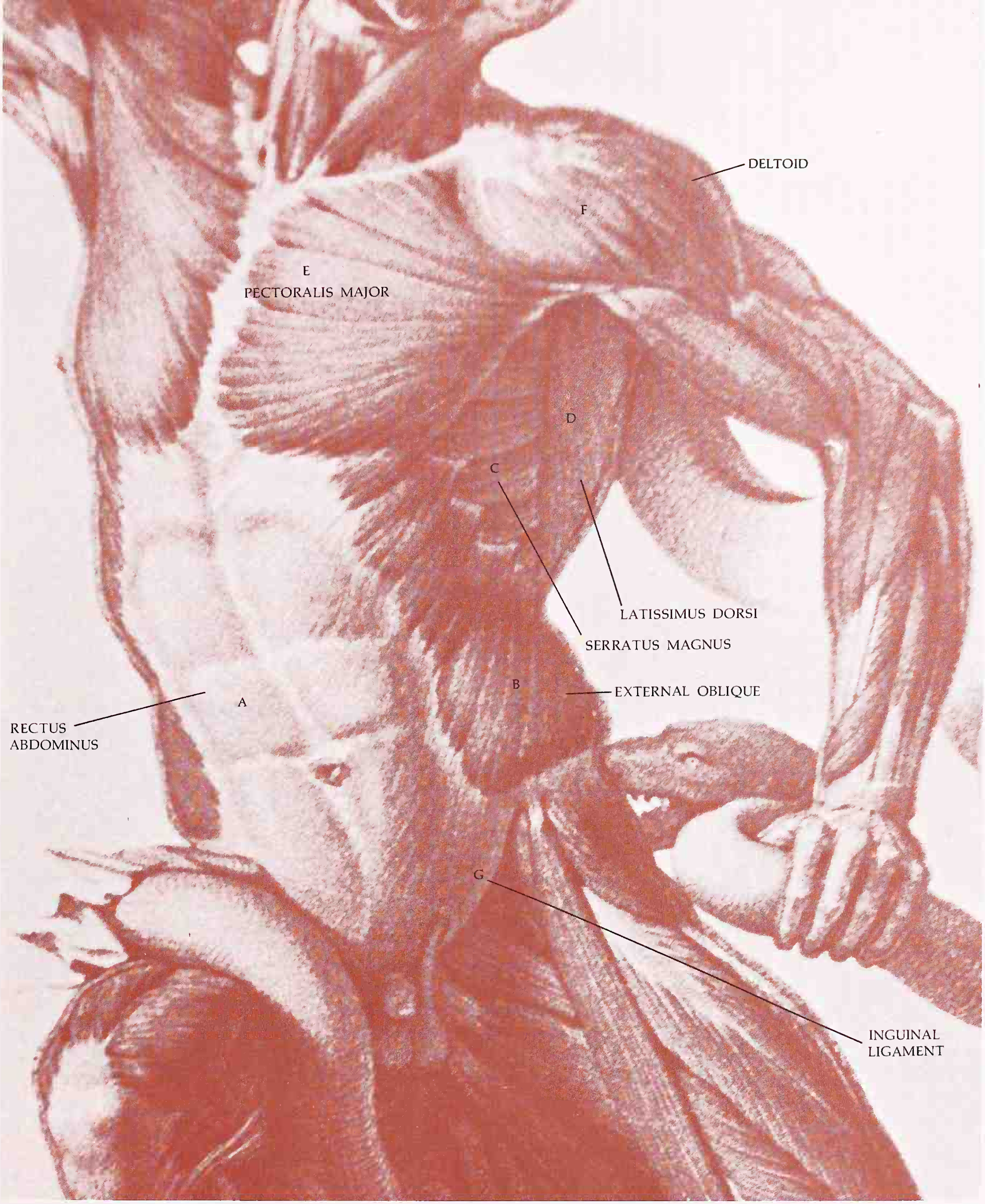


5-40

5-40

Analysis of the Planes of the Abdomen.

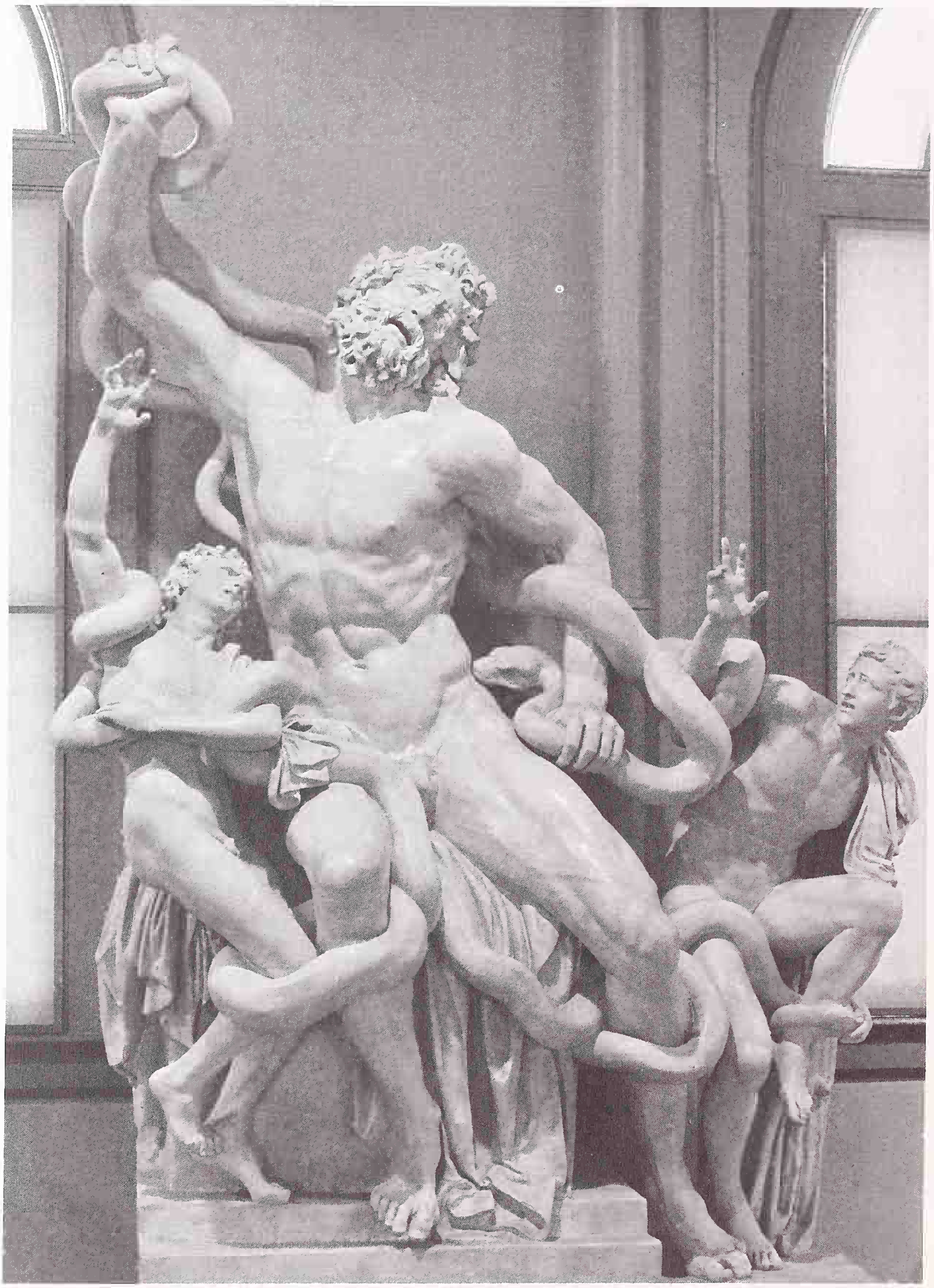
This analysis is based on the drawing by Prud'hon [5-39]. Three broad, vertical planes make up the abdominal form. They bend around the abdomen like a three-paneled screen.


DELTOID
F
E
PECTORALIS MAJOR
D
C
LATISSIMUS DORSI
SERRATUS MAGNUS
B
EXTERNAL OBLIQUE
A
RECTUS
ABDOMINUS
G
INGUINAL
LIGAMENT
5-41

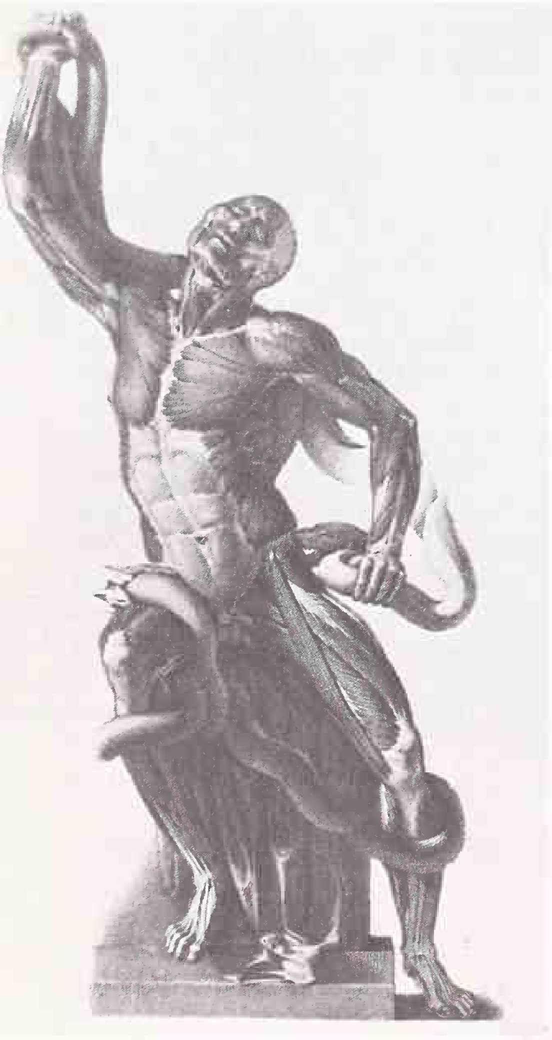
5-41

Detail from Muscle Analysis of the Laocoon, from Anatomie of the External Forms of Man by Julian Fau. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The relationship of the rectus abdominus *(A)*, the external oblique *(B)*, the serratus magnus *(C)*, the latissimus dorsi *(D)*, the pectoralis major *(E)*, the deltoid *(F)*, and the inguinal (Poupart's) ligament *(G)* is clearly illustrated in this figure. The tendinous transverse lines running across the abdomen should not be overstressed, or they will destroy the long vertical planes. (See the drawing by Prud'hon [5-39].) The serpent is biting the tensor fasciae latae and gluteus medius muscles.



5-42



5-43

5-42
The Laocoon Group (plaster cast; in the Horace Smith Collection of the George Walter Vincent Smith Art Museum, Springfield, Massachusetts.)

The muscular analysis by Julian Fau [5-43] is based on the central figure of the Laocoon.

5-43
Muscle Analysis of the Laocoon, from the Anatomy of the External Forms of Man by Julian Fau (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine.) (Photograph by Kalman Zabarsky.)

An instructive example of muscle analysis of the figure in action based on a classic sculpture. At the time the analysis was made the original had been restored, with the arm raised. For this valuable exercise, students should avail themselves of a good reproduction of a masterwork and analyze bone and muscle influence on surface form.

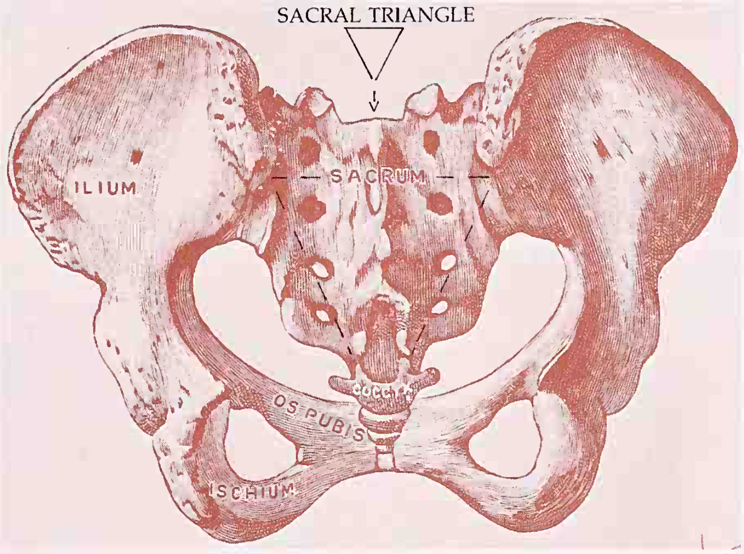
THE BACK

The muscles of the back are numerous but are covered almost completely by two large, broad muscles. These two muscles are strongly influenced by the deeper skeletal and muscular structure beneath [5-45].

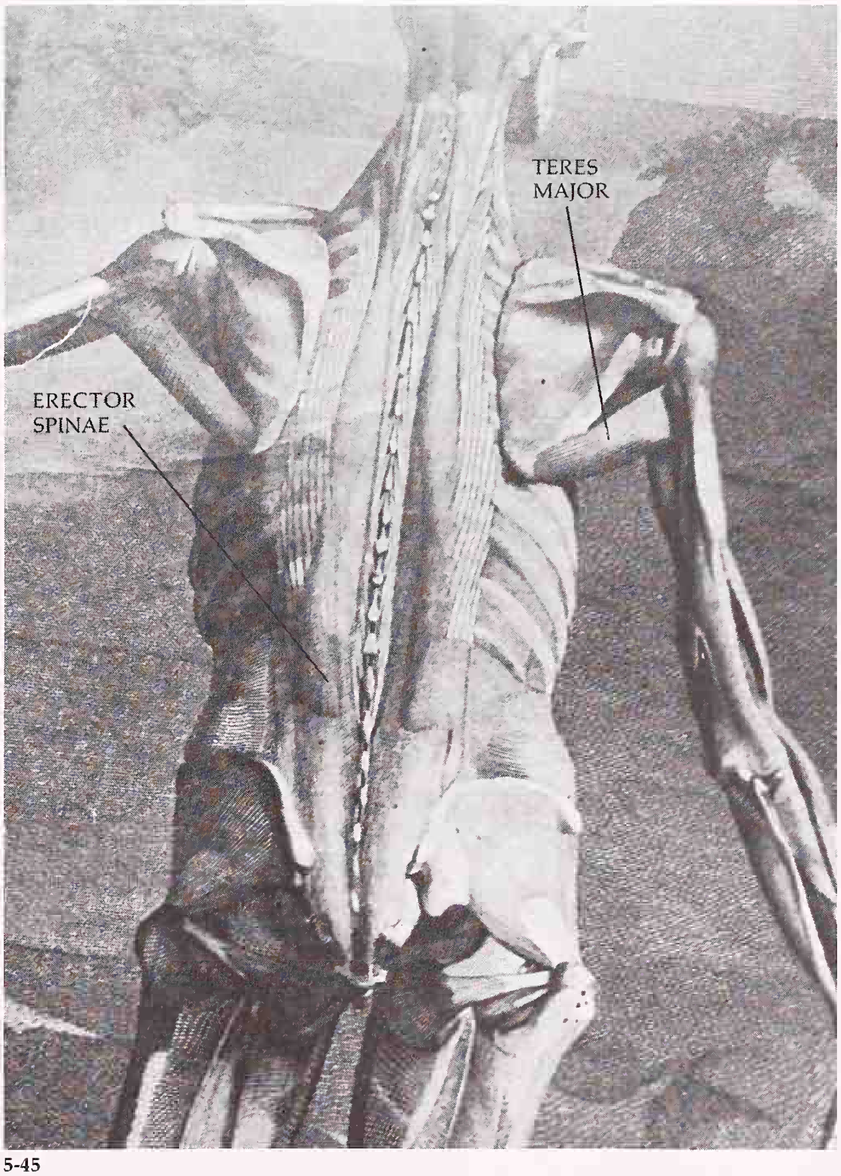
The latissimus dorsi is a wide, flat muscle enclosing the lower back (see 5-54). From an extensive attachment at the rear of the pelvis, it spreads and encloses the lower part and midsection of the rib cage on the back and side. Moving out from the torso, the muscle fibers converge and twist inserting into the bicipital groove of the humerus.

Above the latissimus dorsi the somewhat triangular-shaped trapezius muscle (see 5-53) spreads from its vertebral origin to the ridgelike spine of the scapula out to the shoulder. Its upper portion forms the high, forward-thrusting plane of the back, and it narrows to form the back of the neck inserting into the base of the skull (occipital bone). Beneath these two muscles is an extensive network of smaller muscles that play an important part in filling out the form of the back.

The erector spinae form two long complex muscular and tendinous masses that fill out the groove on either side of the spinous process of the vertebrae extending the full length of the back from the pelvis to the base of the skull [5-45].



5-44



5-45

5-44
Pelvis (Female): Rear View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The sacrum, composed of five fused rudimentary vertebrae, forms a triangular wedge clearly visible in the figure between the buttocks. The shape of the buttocks follows the sacral form as a larger rounded wedgelike volume.

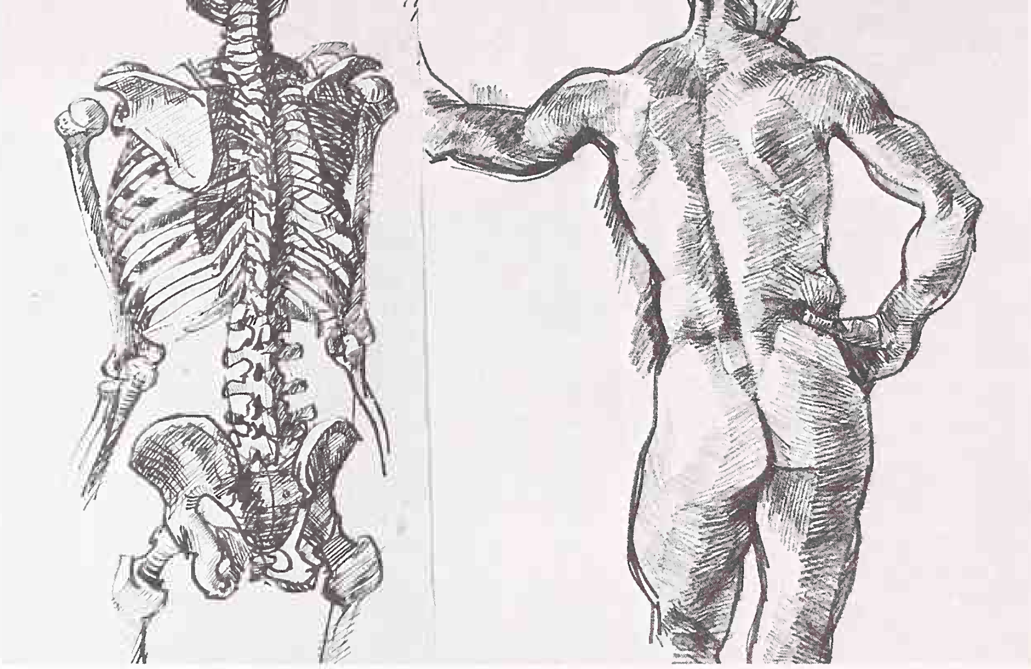
5-45
Detail from Skeleton with the Deep Muscles of the Back, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The erector spinae, the deep supporting muscles of the spine and back, extend from the pelvis to the base of the skull and fill out like two semicylindrical fullnesses on each side of the spinous processes of the vertebrae. (See illustration 5-58.) Shown also free of other muscles are the two teres major muscles extending from the lower border of each shoulder blade to the humerus bone. The teres major is visible above the latissimus dorsi.

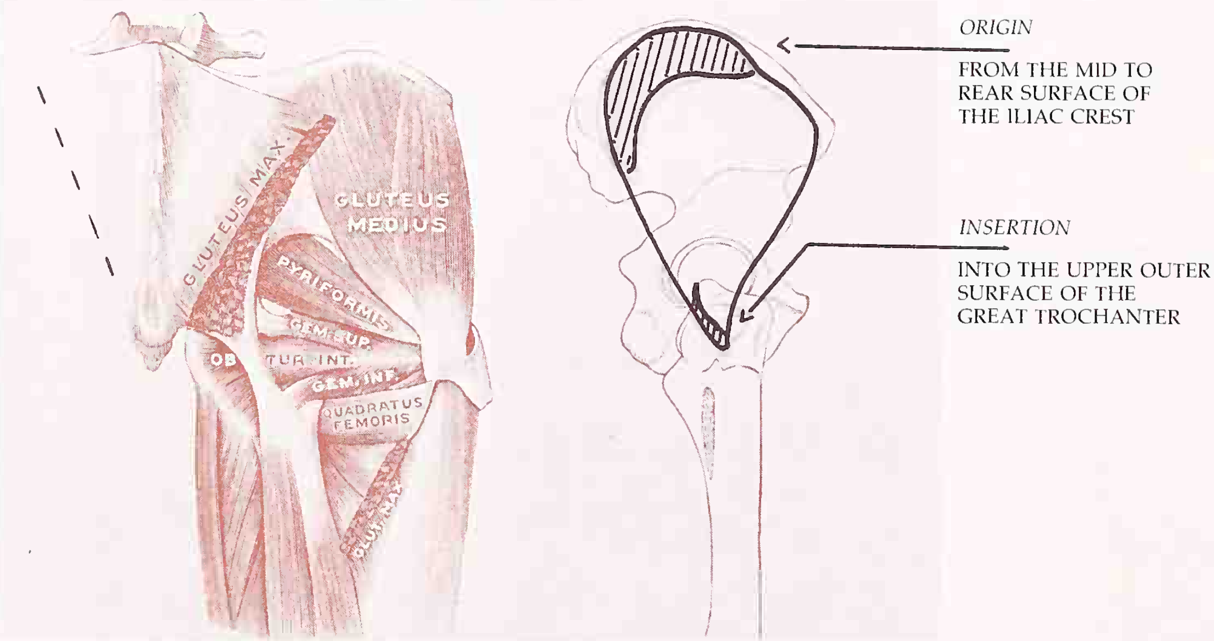
5-46

Skeleton and Figure by Reed Kay (Courtesy: Reed Kay) (Photograph by Iso Papo.)

The skeleton and figure drawings exemplify the correlation between study and performance. Kay, a distinguished draftsman, demonstrates the benefit of disciplined study of anatomy and its application in figure drawing. In the drawing, pressure of the thumb against the iliac crest points to the triangular frame of the sacrum bone.



5-46



5-47

5-47

Gluteus Medius, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The action of the gluteus medius turns the thigh outward and also rotates it inward. It abducts the thigh and draws it forward, and assists in maintaining the trunk erect.

5-48

Gluteus Maximus (above) and Tensor Fasciae Latae (Tensor Vaginae Femoris; below), from the Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The action of the gluteus maximus extends and abducts the thigh, rotates it outward and maintains the trunk erect. The action of the tensor fasciae latae flexes and abducts the thigh and rotates it inward.

5-49

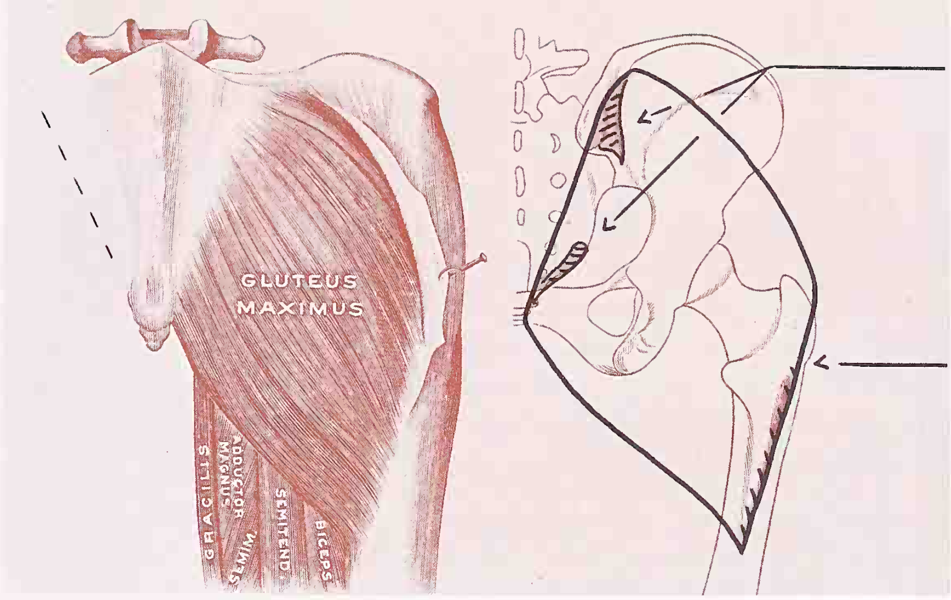
Detail from The Skeleton: Back View, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The triangle at the back of the pelvis is emphasized by the rear portion of the crest of the ilium and the posterior superior iliac spine above the triangular sacrum bone.

5-50

Detail from Model and Mirror.

The sacral triangle is a wedgelike plane above and beneath the buttocks. The fleshy, rounded form of the buttocks has a thrust and direction that reiterates the converging frame of the sacrum. The two upper depressions are aligned horizontally. When the weight of the figure is shifted to one supporting leg, this upper border of the sacrum tilts diagonally down toward the relaxed limb. The angle of the sacrum provides a useful clue to the lean and angle of the overall hip structure. (See 5-58 for the complete drawing.)


GLUTEUS
MAXIMUS
GRACILIS
ADDUCTOR MAGNUS
SEMIM.
SEMITEND.
BICEPS

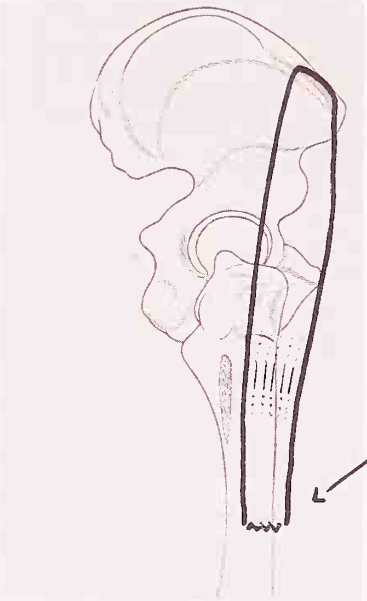
GLUTEUS MAXIMUS

ORIGIN

FROM POSTERIOR ILIAC CREST, THE SACRUM, AND COCCYX

INSERTION

INTO THE GREAT TROCHANTER AND REAR UPPER SHAFT OF THE FEMUR



TENSOR FASCIAE LATAE

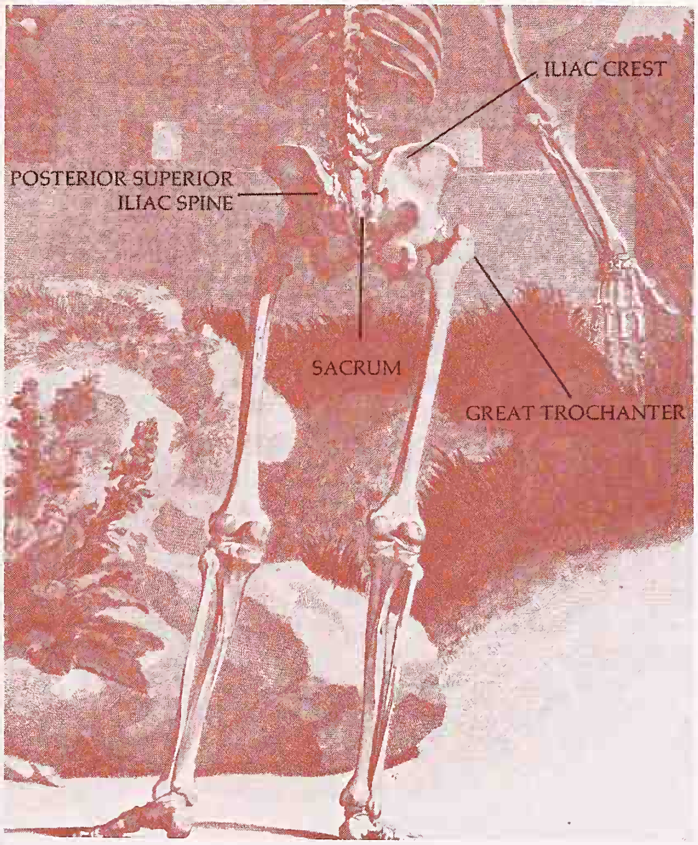
ORIGIN

FROM ANTERIOR SUPERIOR ILIAC SPINE OF ILIUM

INSERTION

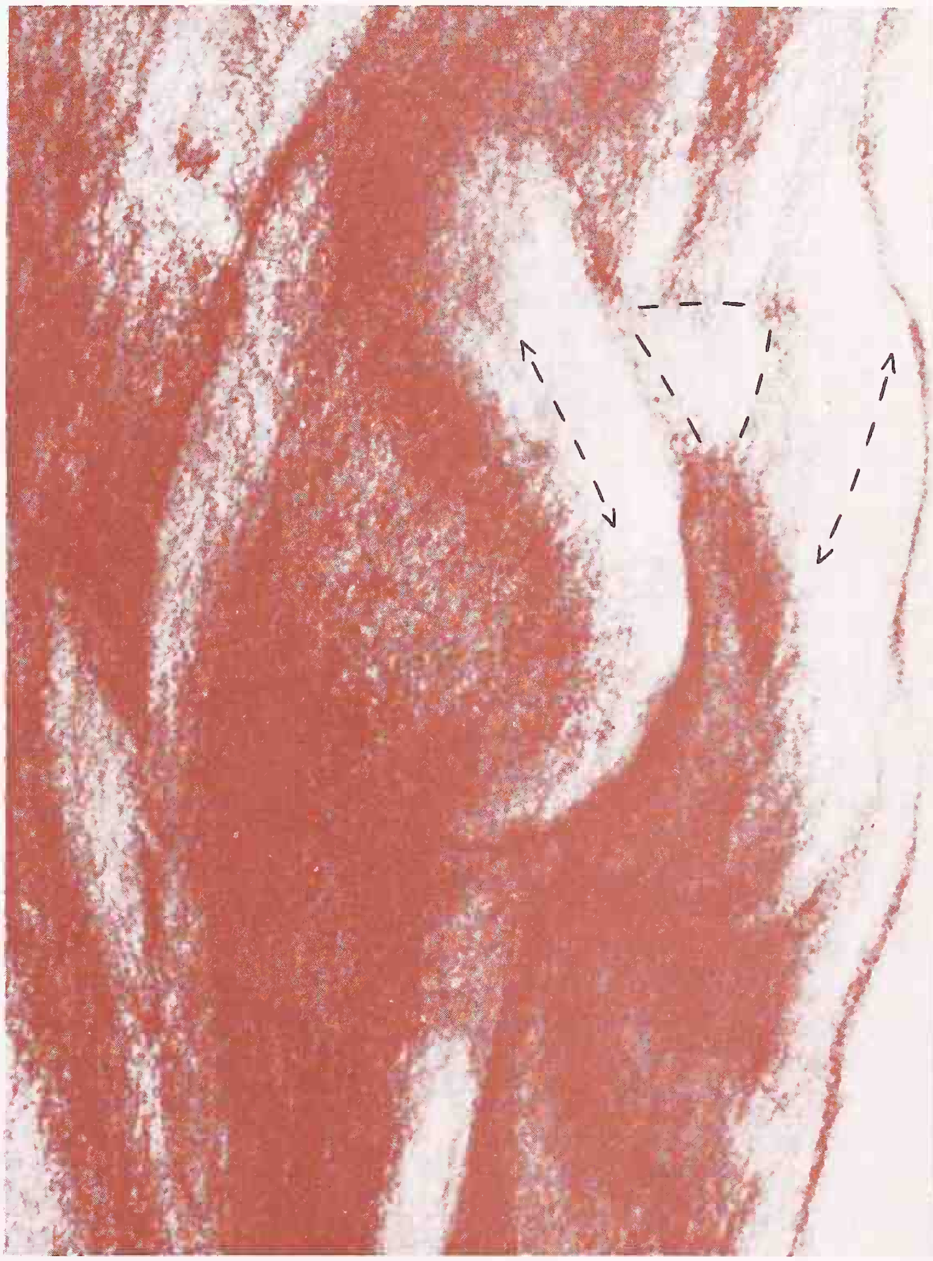
PASSES OVER AND IN FRONT OF THE GREAT TROCHANTER INTO THE ILIO-TIBIAL BAND AT THE OUTER SIDE OF THE THIGH

5-48

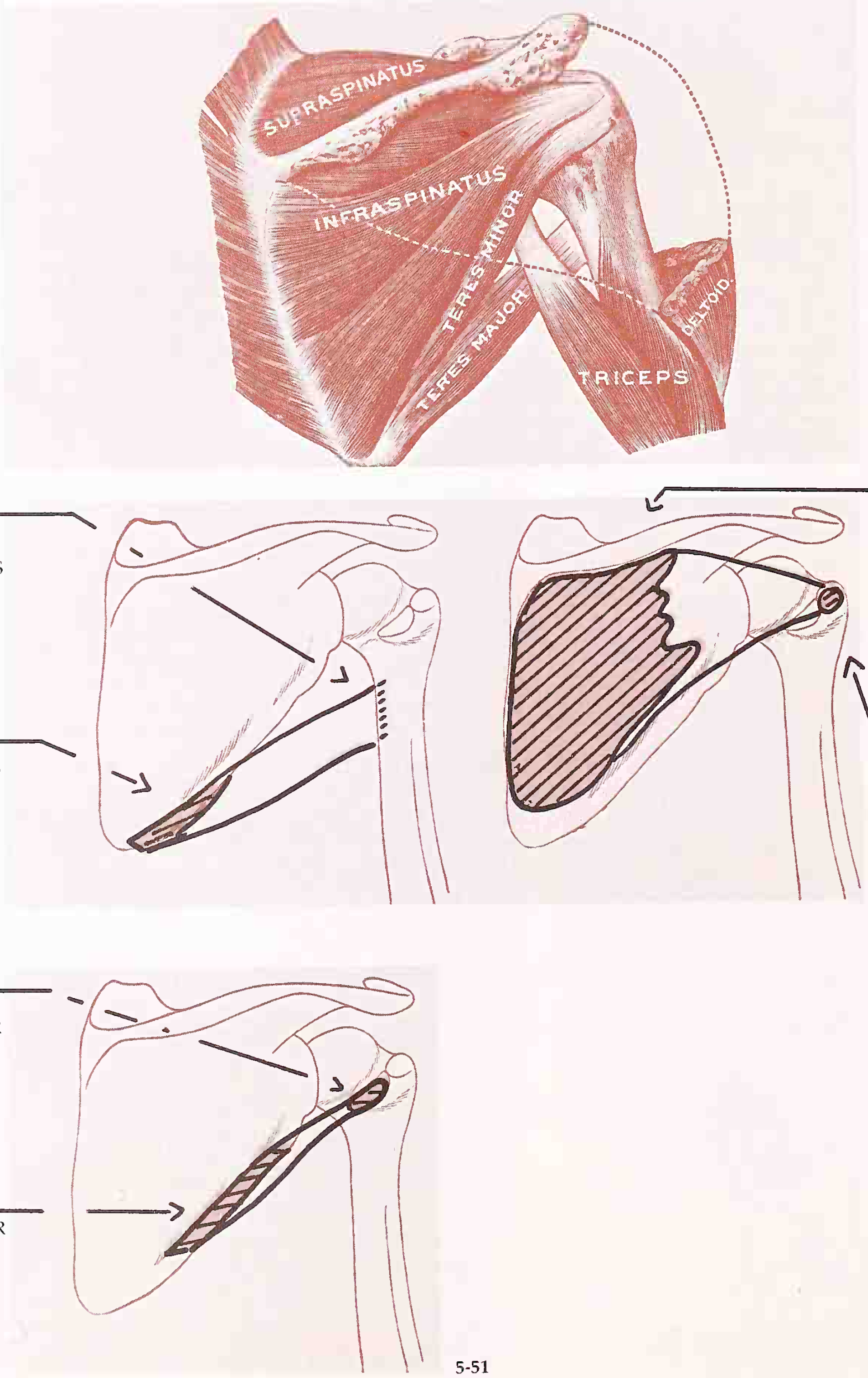

ILIAC CREST
POSTERIOR SUPERIOR ILIAC SPINE
SACRUM
GREAT TROCHANTER

5-49

5-50



Two additional muscle groups in the upper back should be studied and observed with care. They are: (1) the three muscles that spread between the spine and the inner border of the scapula (shoulder blade) and draw the shoulder blade in toward the spine—the rhomboid major, the rhomboid minor, and the levator anguli scapulae; (2) the four muscles (see 5-52) that extend from the scapula to the upper humerus bone and act to rotate and to lower the raised arm—the supraspinatus, the infraspinatus, the teres minor, and the teres major (see 5-51).



5-51
Diagrams of the Infraspinatus, Teres Major, and Teres Minor.

The action of the infraspinatus is to rotate the humerus outward. The teres major draws the arm down and back, assisting the latissimus dorsi. The teres minor rotates the humerus outward.

INSERTION

INTO THE BICIPITAL
RIDGE OF THE UPPER
SHAFT OF THE HUMERUS

TERES MAJOR
ORIGIN

FROM THE LOWER TIP
AND OUTER BORDER OF
THE SCAPULA

INFRASPINATUS
ORIGIN

FROM THE BROAD
TRIANGULAR SURFACE
OF THE SCAPULA
BELOW THE SPINE

INSERTION

INTO THE UPPER SURFACE
OF THE GREATER TUBEROSITY
OF THE HUMERUS

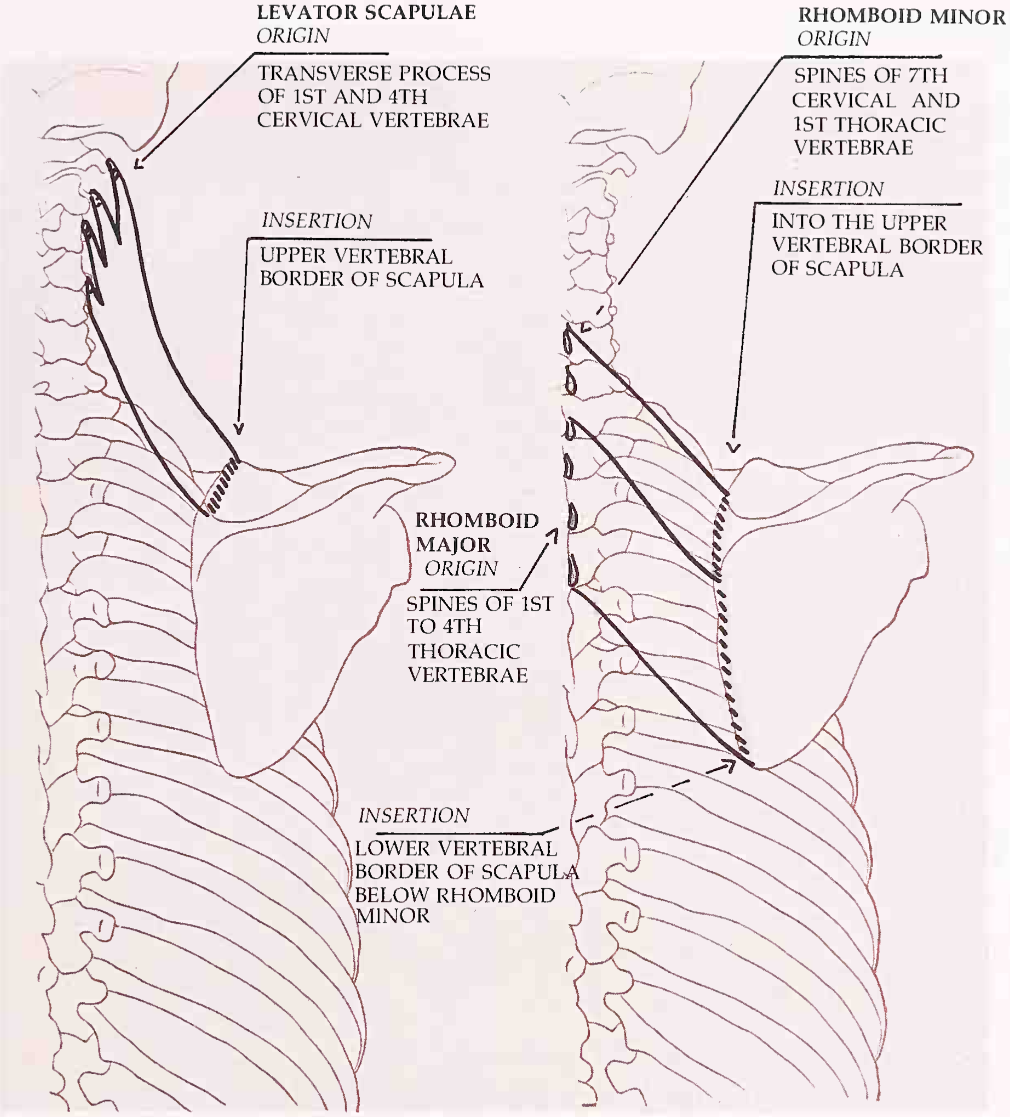
INSERTION

INTO THE LOWEST
FACET OF THE GREATER
TUBEROSITY OF THE
HUMERUS

TERES MINOR
ORIGIN

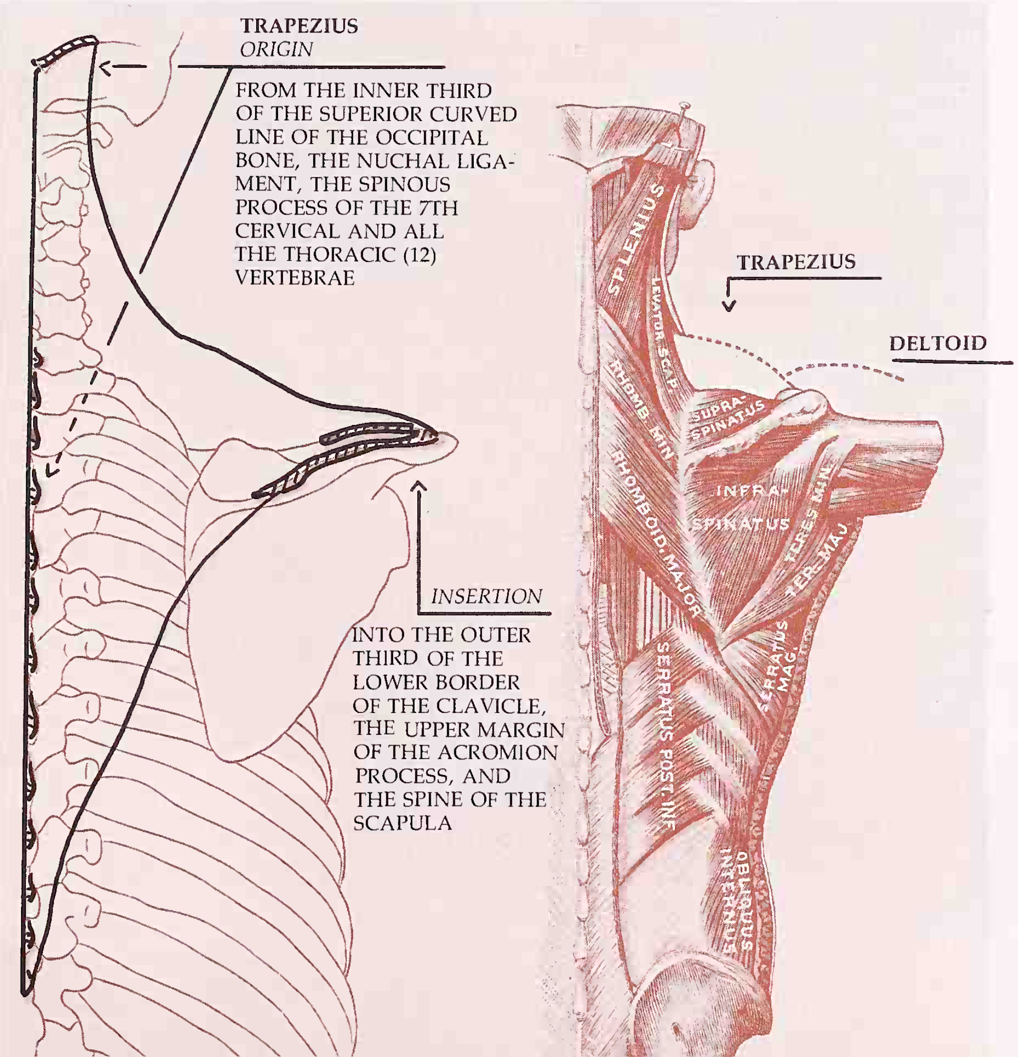
FROM THE MID TO UPPER
OUTER BORDER OF THE
SCAPULA

5-51


LEVATOR SCAPULAE
ORIGIN
TRANSVERSE PROCESS OF 1ST AND 4TH CERVICAL VERTEBRAE
INSERTION
UPPER VERTEBRAL BORDER OF SCAPULA
RHOMBOID MINOR
ORIGIN
SPINES OF 7TH CERVICAL AND 1ST THORACIC VERTEBRAE
INSERTION
INTO THE UPPER VERTEBRAL BORDER OF SCAPULA
RHOMBOID MAJOR
ORIGIN
SPINES OF 1ST TO 4TH THORACIC VERTEBRAE
INSERTION
LOWER VERTEBRAL BORDER OF SCAPULA BELOW RHOMBOID MINOR

5-52

5-53

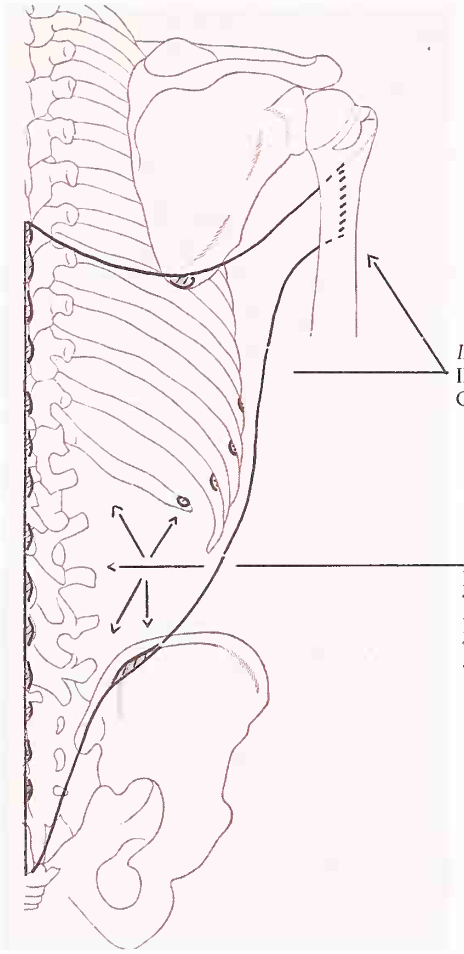

TRAPEZIUS
ORIGIN
FROM THE INNER THIRD OF THE SUPERIOR CURVED LINE OF THE OCCIPITAL BONE, THE NUCHAL LIGAMENT, THE SPINOUS PROCESS OF THE 7TH CERVICAL AND ALL THE THORACIC (12) VERTEBRAE
INSERTION
INTO THE OUTER THIRD OF THE LOWER BORDER OF THE CLAVICLE, THE UPPER MARGIN OF THE ACROMION PROCESS, AND THE SPINE OF THE SCAPULA
TRAPEZIUS
DELTOID
SPLENIUS
LEVATOR SCAP.
RHOMB. MIN.
RHOMBOID. MAJOR
SUPRA-SPINATUS
INFRA-SPINATUS
TERES MIN.
TER. MAJ.
SERRATUS MAG.
SERRATUS POST. INF.
OBLIQUUS INTERNUS

5-52
The Levator Scapulae Muscle, the Rhomboid Minor Muscle, and the Rhomboid Major Muscle. (Photograph by Iso Papo.)

The action of the levator scapulae is to raise the scapula and turn the neck to the side. The rhomboid minor and the rhomboid major draw the scapula upward and toward the vertebral column.

5-53
Diagram of the Trapezius. (Photograph by Iso Papo.)

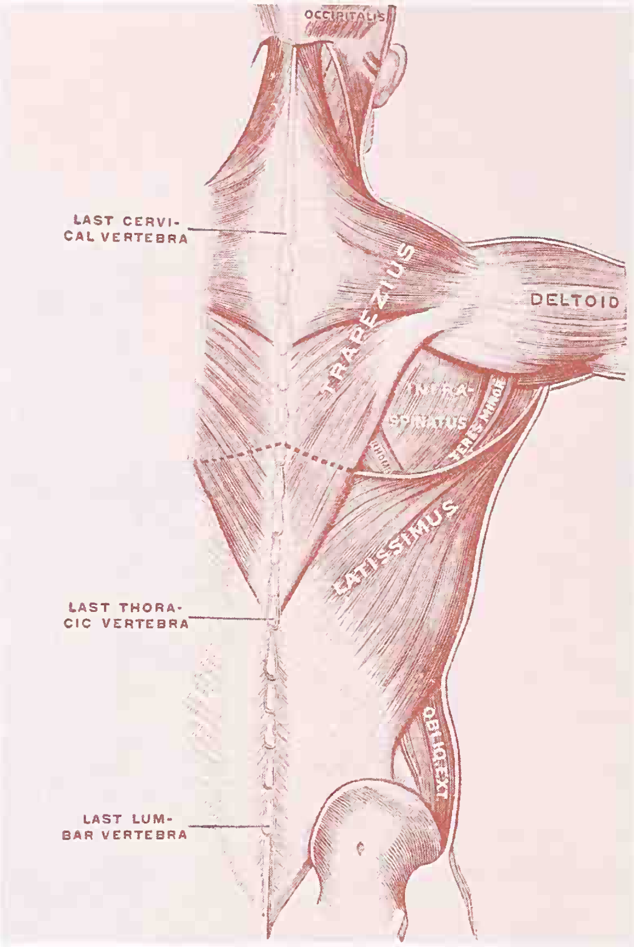
The action of the trapezius is complex. The upper portion draws the head backward and/or elevates the scapula. The middle and lower portions draw the scapula toward the spinal column to "square" the shoulders.



INSERTION
INTO THE BICIPITAL
GROOVE OF THE HUMERUS

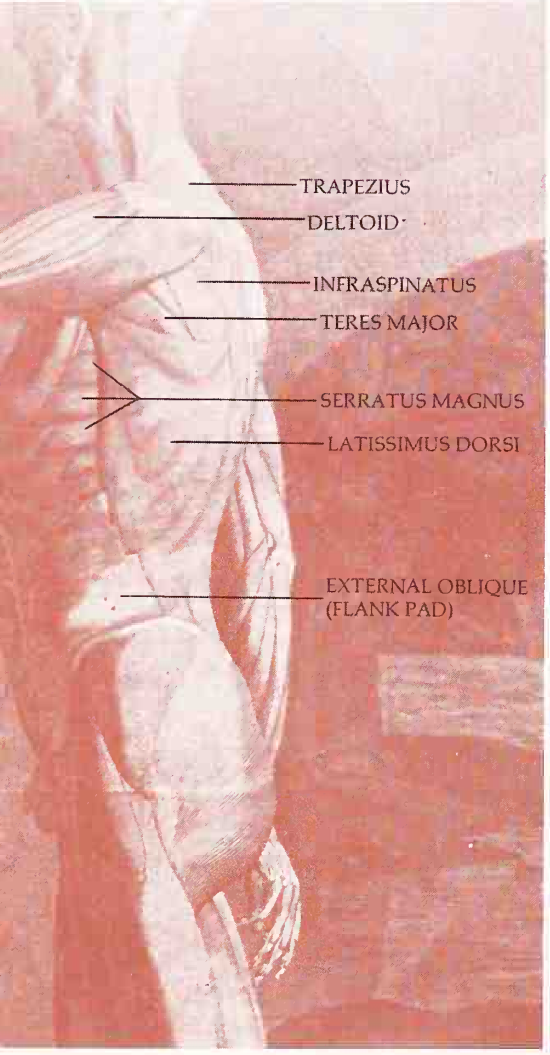
ORIGIN
FROM THE SPINES OF
THE 6 LOWER THORACIC,
LUMBAR, AND SACRAL VERTEBRAE,
THE CREST OF THE ILIUM, AND
THE LOWER 3 OR 4 RIBS

5-54


OCCIPITALIS
LAST CERVICAL VERTEBRA
TRAPEZIUS
DELTOID
INFRA-SPINATUS
TERES MINOR
RHOMB.
LATISSIMUS
LAST THORACIC VERTEBRA
OBLIQ. EXT.
LAST LUMBAR VERTEBRA

5-55

5-56


TRAPEZIUS
DELTOID
INFRASPINATUS
TERES MAJOR
SERRATUS MAGNUS
LATISSIMUS DORSI
EXTERNAL OBLIQUE (FLANK PAD)

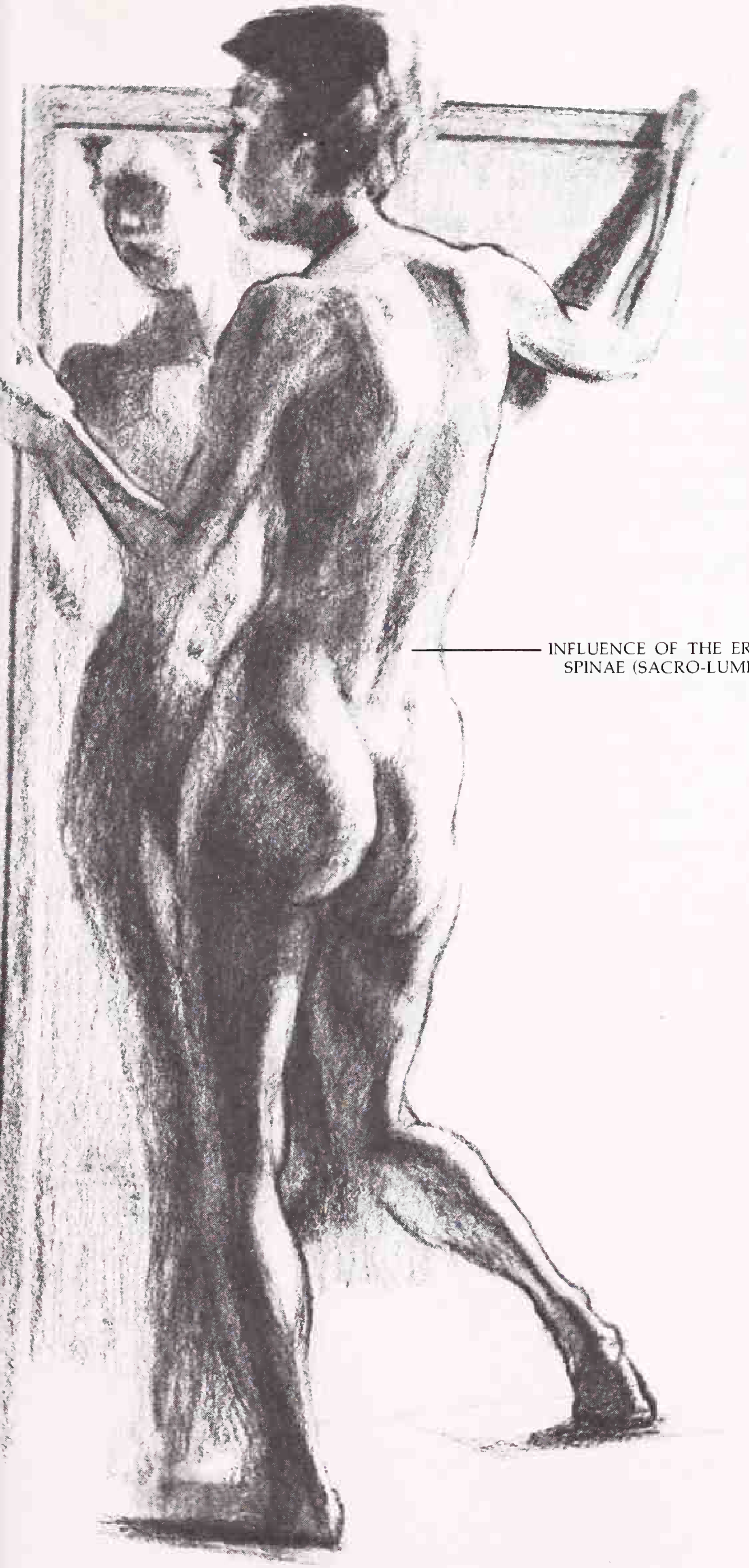
The trunk, shown from the front and back, is marked by a median division running the full length of the form in both views. In the back, this is the spinal column (see 5-9, 5-10). In the front, the median division extends from the pit of the neck to the pubic symphysis, running through the sternum and the linea alba (dividing the rectus abdominus) [5-41, 5-42]. One of the problems of foreshortening the torso can be profitably discussed in relation to this central division.

Three-quarter-view drawings of the torso are invariably given too wide a dimension from the median line to the far contour in the drawing. When this happens, the distant part of the form competes with the near (dominant) form and confuses the space. Then, the overextended dimension of the far surface does not keep its position and distance behind the nearer parts of the figure.

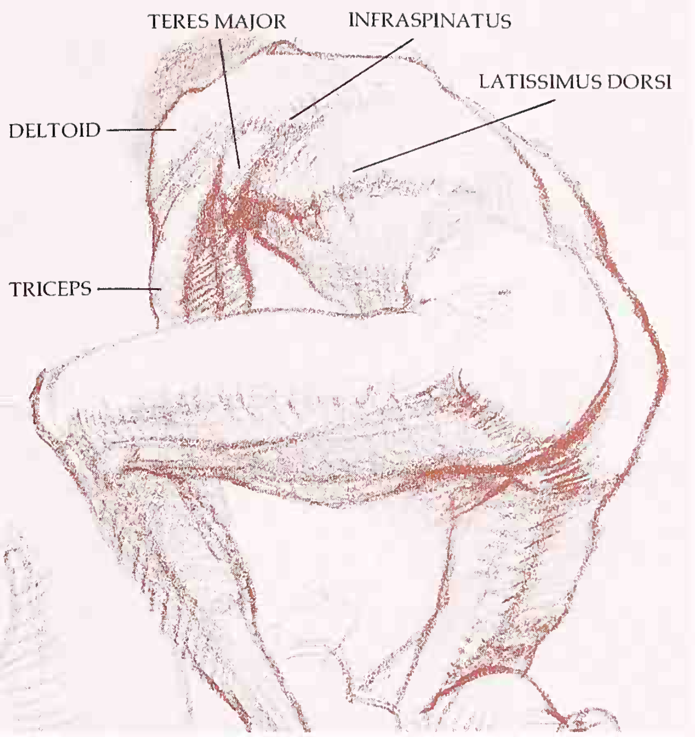
In a front three-quarter view, both side and front are seen on the near part of the figure, while only part of the front is seen on the distant side of the median line [5-23, 5-28]. This should be noted and measured with a vigilant eye. The distance from midline to far contour, carefully observed as to dimension, quite simply can set the space convincingly back. The same consideration should be made for the back, comparing the distance from the spine to far contour with the near section of the back and side of the figure [5-10, 5-58].

The lean of the hips, when the weight of the figure has been shifted to one leg [5-46], can be quickly traced on the back surface of the body in the dimpled triangle of the sacrum bone set between and slightly above the buttocks. (In the skeleton [5-44], the sacrum bone joins the two units of the pelvis, the os innominatum.)

Though they appear gradually rounded, the form of the buttocks often has a subtly converging movement, following the converging sides of the sacral triangle [5-50]. The location of the sacrum (visible by its dimples) is, therefore, essential. It also identifies a broad, steplike plane opposing the direction of the mid and lower back [5-48, 5-50]. Dominating the muscular form in this area is the large, strong gluteus maximus (padded below by additional fatty tissue) [5-48].


INFLUENCE OF THE ERECTOR SPINAE (SACRO-LUMBALIS)

5-58



5-57

5-54
Diagram of the Latissimus Dorsi (Photograph by Iso Papo.)

The action of the latissimus dorsi is to draw the arm down and backward. It also raises the lower ribs and abducts the arm.

5-55
Superficial Muscles of the Back, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

5-56
Detail from The Muscles of the Side and Back of the Torso, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

Beneath the shoulder and back muscles, the bony triangular frame of the scapula and the larger volume of the rib cage are visible. The transition of muscles over the side of the torso may be seen here and in illustration 5-57.

5-57
Bending Figure by the author. (Photograph by Jonathan Goell.)

On this muscular model the turn of the latissimus dorsi envelops the rounded rib cage below. Other muscles of the back are clearly visible and are labeled.

5-58
Model and Mirror by the author. (Photograph by Kalman Zabarsky.)

On the slender model, the two columnar fullnesses rising from the sacrum on each side of the spine show the influence of the erector spinae muscles on the form of the lower back. (Compare this with illustration 5-45.) The spinal column in the back and the median line in the front of the torso are useful guides to foreshortening in the three-quarter view of the figure. The distance from the spine to the far contour of the torso should be very carefully noted and compared with the larger dimension from the spine to the near contour. This simple judgment, so frequently ignored or carelessly observed, holds the smaller form convincingly behind and away from the viewer. (An enlarged far form unit competes with the near volume and confuses the space.)

Study Assignment

Spinal Column and Muscles of Spine

Draw a careful study of spinal curves from a straight side view. Do not draw individual vertebrae. Focus on curvature.

1. Identify length and curvature of cervical vertebrae.
2. Identify thoracic curve.
3. Identify lumbar vertebrae and curve.
4. Identify sacral curve.

Specific individual vertebrae may be examined in detail in a separate study. Draw two or three vertebrae and articulations.

Muscles: draw erector spinae.

Study Assignment

Torso

Make separate drawings of the following skeletal structures: spinal column, pelvis, rib cage, and shoulder girdle.

Draw muscles of the torso front: pectoralis major, rectus abdominus, flank pad (transversalis, internal oblique, external oblique).

Draw muscles of the torso back: erector spinae, rhomboids, infraspinatus, teres major, trapezius, latissimus dorsi, gluteal muscles, and so on.

Regional structures in the torso are listed for separate study in the following exercises.

Study Assignment

Thorax (rib cage and muscles of upper torso)

Draw overall, egglike form of rib cage from front and side.

Observe spinal curve in relation to sternum. Study attachment of rib to vertebra. Study curvature of individual ribs and identify angle.

Draw sternun and cartilage of true ribs.

Muscles

Draw erector spinae, serratus magnus, pectoralis major, trapezius, and lattisimus dorsi.

Study Assignment

Shoulder Girdle and Muscles of Upper Torso

Draw clavicle and articulation with acromion process of scapula.

Draw scapula and articulation with clavicle.

Indicate articulation of clavicle and sternum.

Indicate the scale of scapula to rib cage.

Draw muscles of upper torso and neck: deltoid, trapezius, pectoralis major, rhomboids, sterno-cleido-mastoid, and so on.

Study Assignment

Pelvis and Gluteal Muscles

Study bones of pelvic structure as a unit (sacrum plus os innominatum). Structure as two stacked basins and cut away excess.

Draw three views: front, side, and back.

Draw gluteal and flank pad muscles (gluteus medius, gluteus maximus, tensor fasciae latae, external oblique, and so on).

THE UPPER EXTREMITY

Bones of the Arm, Wrist, and Hand

ARM
- humerus
  - head, neck
  - tuberosities (2)
  - external condyle
  - internal condyle
  - trochlea
  - capitellum
  - olecranon cavity
- radius
  - head
  - bicipital tuberosity
  - styloid process
- ulna
  - olecranon process
  - sigmoid cavity
  - styloid process

WRIST AND HAND
- carpus (8 bones)
  - trapezium
  - scaphoid
  - lunate
  - cuneiform
  - pisiform
  - trapezoid
  - os magnum
  - unciform
- metacarpals
- phalanges

Muscles of the Arm and Hand

UPPER ARM MUSCLES
- deltoid
- coraco brachialis
- brachialis anticus
- biceps
- triceps
- anconeus

FOREARM MUSCLES
- flexor digitorum sublimus
- flexor pollicis longus
- pronator quadratus
- pronator radii teres
- flexor carpi radialis
- palmaris longus
- flexor carpi ulnaris
- abductor pollicis longus
- extensor pollicis brevis
- extensor pollicis longus
- extensor indicis
- extensor carpi ulnaris
- extensor communis digitorum
- extensor minimi digiti
- extensor carpi radialis brevis
- extensor carpi radialis longus
- supinator longus (brachioradialis)

HAND MUSCLES
- lumbricales
- interossei palmares
- interossei dorsales
- palmaris brevis
- abductor minimi digiti
- flexor brevis minimi digiti
- opponens minimi digiti
- abductor pollicis
- opponens pollicis
- flexor pollicis brevis

CHAPTER 6

THE UPPER EXTREMITY: ARM, WRIST, AND HAND

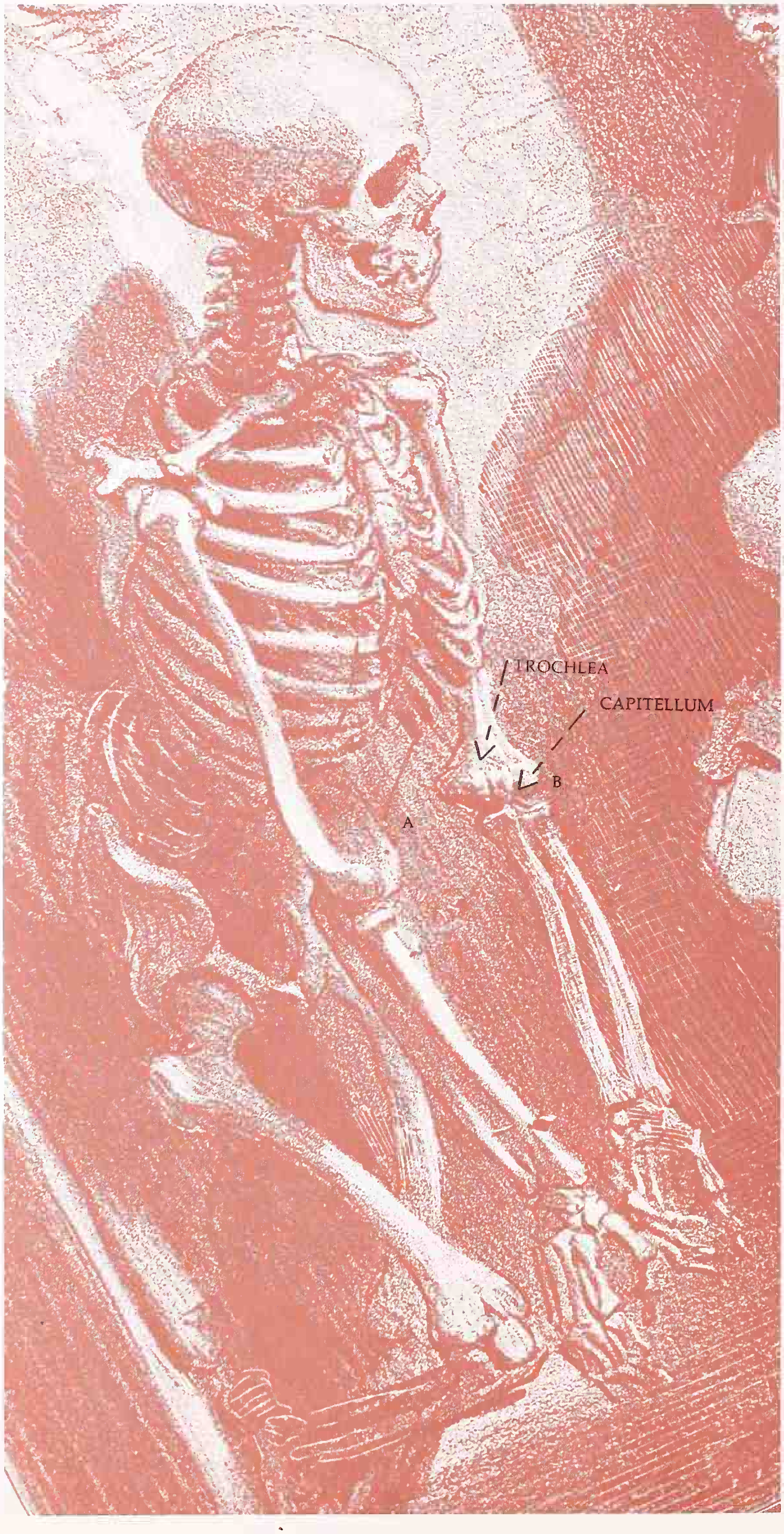
The arm, with its remarkably accommodating range of articulation, presents a challenging exercise in understanding. A ball-and-socket joint at the shoulder and the arm's two-way articulation at the elbow (both hinge and rotary action), extending to the intricate action at the wrist, allow for involved and subtle changes of form [6-1]. Add to this the articulation of the fingers controlled by muscles in the forearm, plus the important muscles of the upper arm, and one can discover a multitude of possible relationships within this appendage. A selective examination of the influential anatomy may be a helpful guide to understanding this form and its variability of shape and movement.

THE UPPER ARM

The acromion process of the scapula (the flat outer extension of its spine) forms the limit that joins the top plane of the torso to the side plane of the shoulder mass. Below is the projecting fullness of the head of the humerus. The acromion process extends the plane and direction of the clavicle. This connection, usually marked on the skin surface, is not always easy to identify. (See the section on the shoulder girdle, chapter 5, page 102.)

The upper arm, made up of one long bone (the humerus) [6-2] and relatively few muscles, has large and apparent volumes. Surrounding the ball-and-socket joint of the shoulder is the strong, well-padded deltoid muscle attached in front to the outer third of the clavicle along the outer edge of the acromion process and in back, extending the full length of the spine of the scapula. The fibers converge to an insertion almost half the length of the cylindrical shaft of the humerus on the outer side of the arm.

The shaft of the humerus is thickly padded through its length. At the elbow, the two bony epicondyles of the humerus are clearly exposed at this hinge articulation [6-1, 6-2].

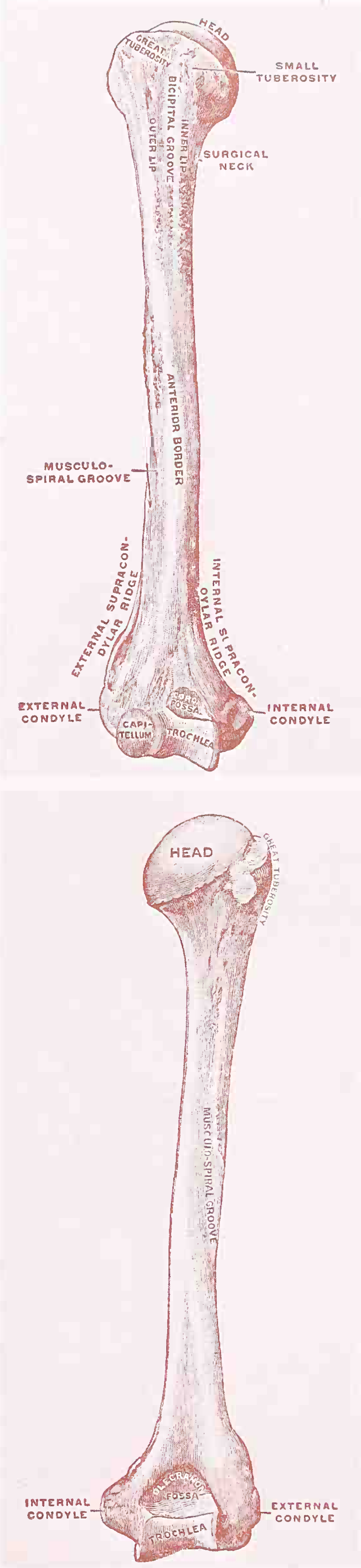


6-1
Detail from Vous etes bien long, jeune homme by Auguste Raffet. (Collection: the author. Photograph by Kalman Zabarsky.)

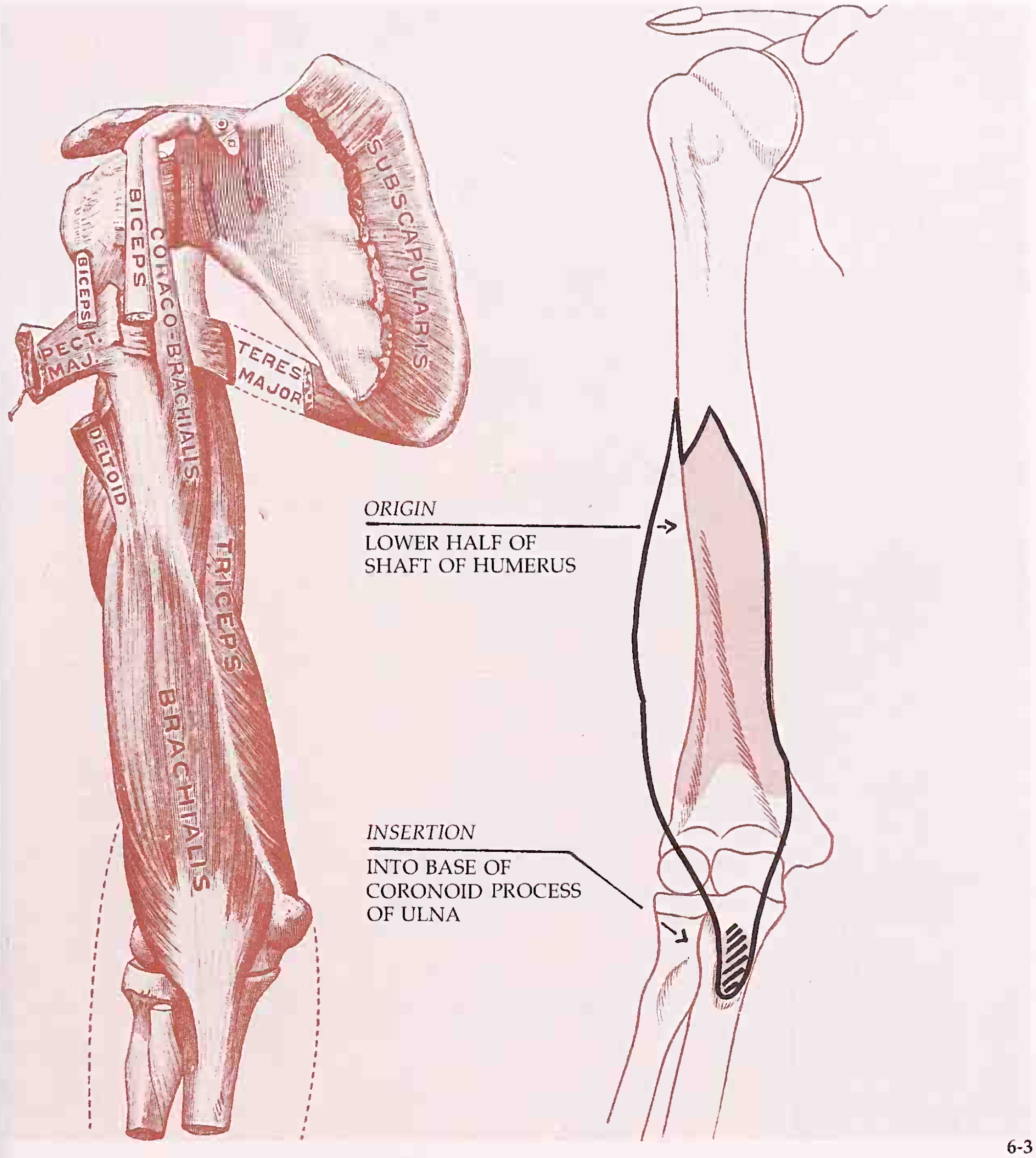
The two epicondyles of the humerus are the internal epicondyle *(A)* and the external epicondyle *(B)*. The arrow indicates the trochlea, the spool-like articular surface of the humerus bone.

The biceps, the best known and most obvious muscle in the arm, by its prominence gives the arm a great deal of its character [6-4]. Beneath the biceps and largely hidden is the deep but influential brachialis anticus. This muscle causes much of the projecting volume of the biceps [6-3, 6-4, 6-7].

6-2

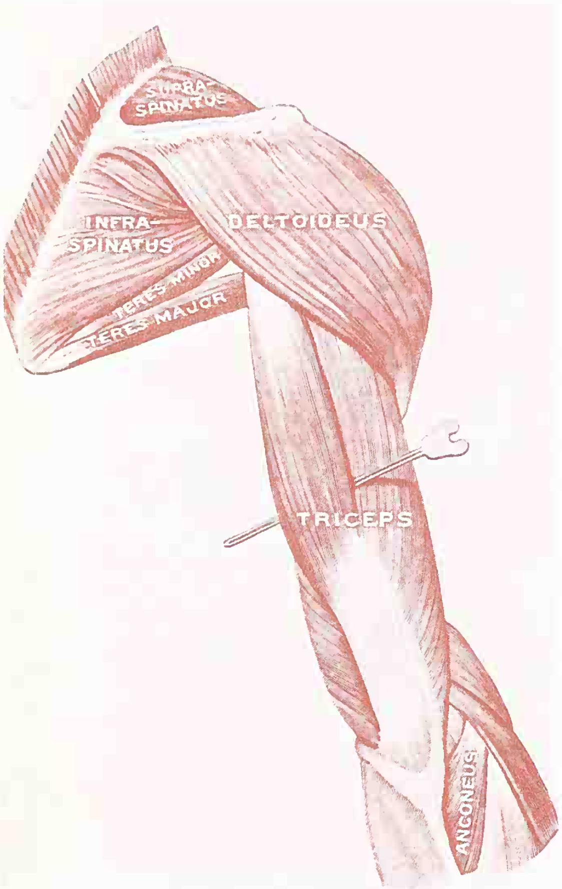

HEAD
GREAT TUBEROSITY
SMALL TUBEROSITY
BICIPITAL GROOVE
INNER LIP
OUTER LIP
SURGICAL NECK
ANTERIOR BORDER
MUSCULO-SPIRAL GROOVE
EXTERNAL SUPRACONDYLAR RIDGE
INTERNAL SUPRACONDYLAR RIDGE
EXTERNAL CONDYLE
INTERNAL CONDYLE
FOSSA
CAPITELLUM
TROCHLEA
HEAD
GREAT TUBEROSITY
MUSCULO-SPIRAL GROOVE
INTERNAL CONDYLE
OLECRANON FOSSA
EXTERNAL CONDYLE
TROCHLEA

6-2
The Right Humerus Bone, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)
A front view is illustrated above and a rear view below.

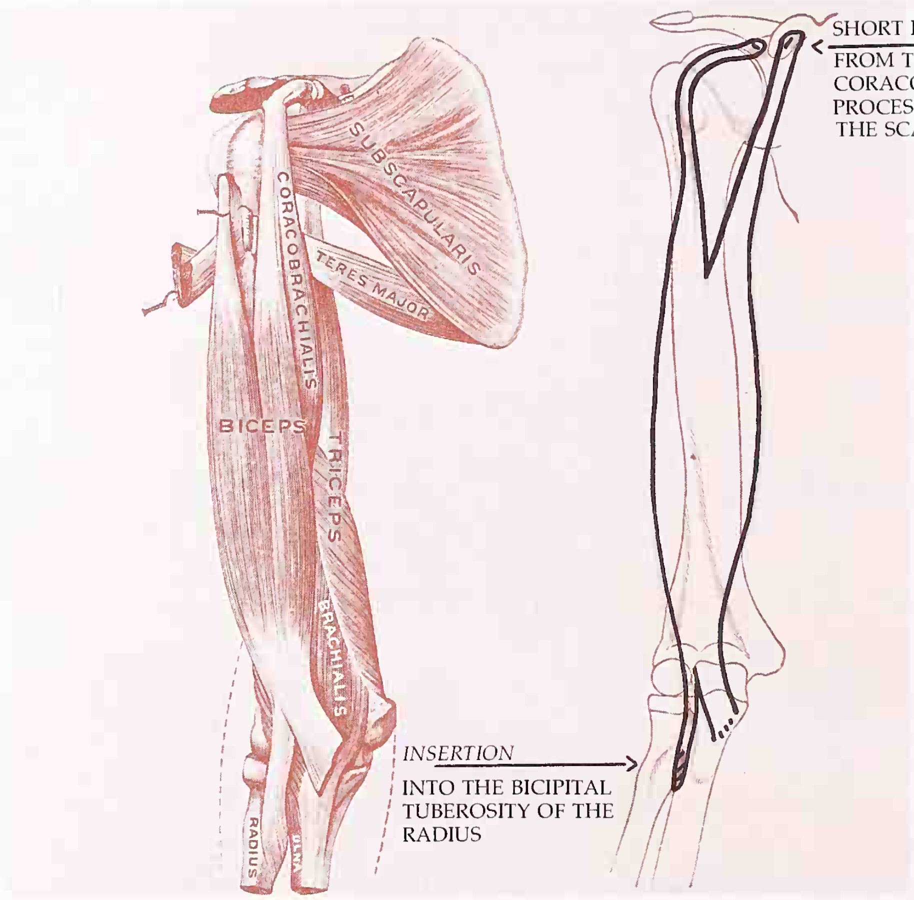

SUBSCAPULARIS
BICEPS
CORACO-BRACHIALIS
BICEPS
PECT. MAJ.
TERES MAJOR
DELTOID
TRICEPS
BRACHIALIS
ORIGIN
LOWER HALF OF SHAFT OF HUMERUS
INSERTION
INTO BASE OF CORONOID PROCESS OF ULNA

6-3

6-3
The Brachialis of the Right Arm, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)
The brachialis anticus muscle lies beneath the biceps. It is substantial and adds considerably to the volume of the upper arm. This muscle flexes the arm.


SUPRA-SPINATUS
INFRA-SPINATUS
DELTOIDEUS
TERES MINOR
TERES MAJOR
TRICEPS
ANCONEUS

6-4


SUBSCAPULARIS
CORACOBRACHIALIS
TERES MAJOR
BICEPS
TRICEPS
BRACHIALIS
RADIUS
ULNA

ORIGIN

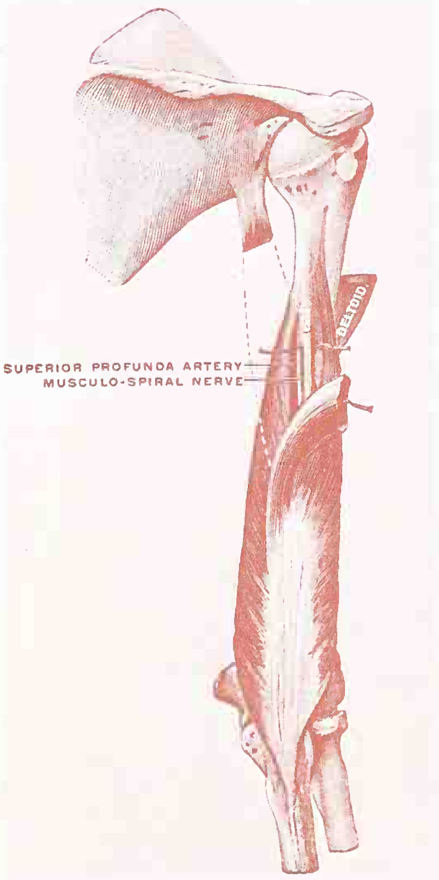
LONG HEAD: FROM THE UPPER MARGIN OF THE GLENOID CAVITY OF SCAPULA

SHORT HEAD: FROM THE CORACOID PROCESS OF THE SCAPULA

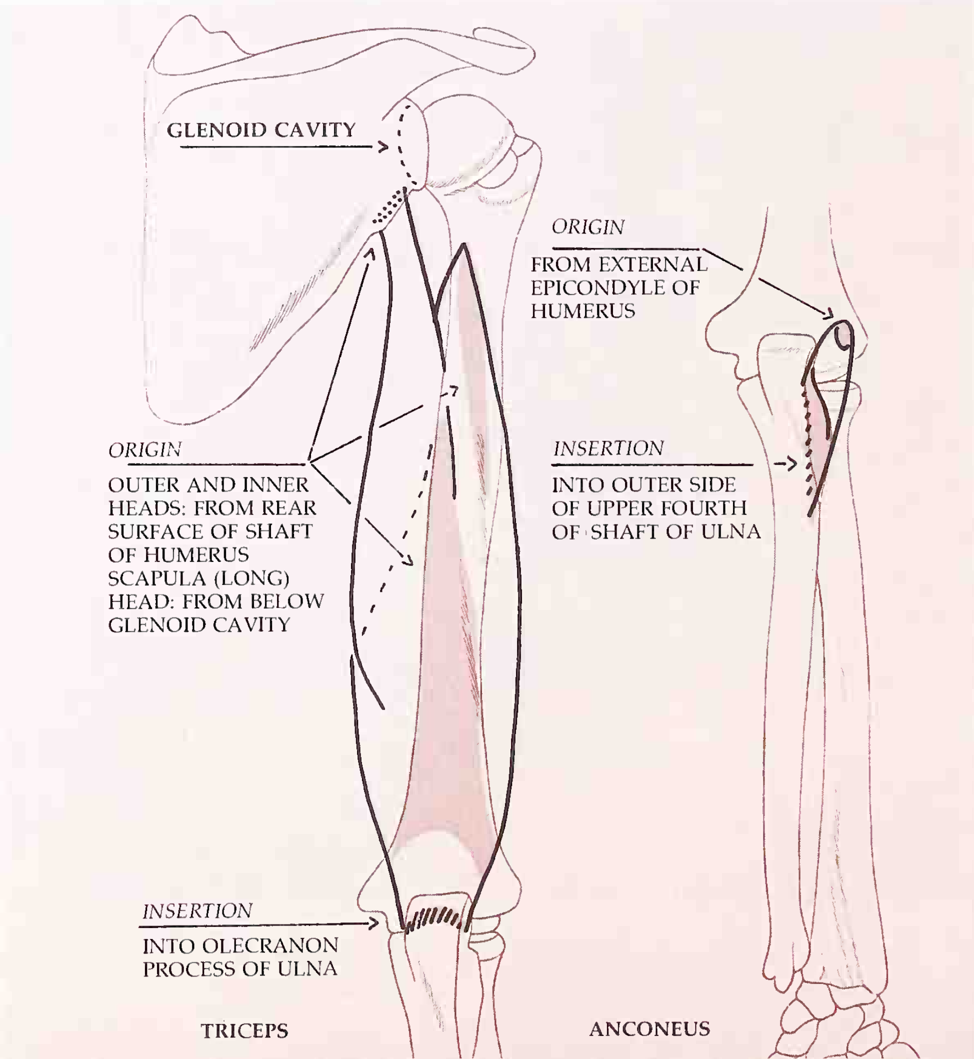
INSERTION

INTO THE BICIPITAL TUBEROSITY OF THE RADIUS

6-5


SUPERIOR PROFUNDA ARTERY
MUSCULO-SPIRAL NERVE
DELTOID

6-6


GLENOID CAVITY

ORIGIN

OUTER AND INNER HEADS: FROM REAR SURFACE OF SHAFT OF HUMERUS SCAPULA (LONG) HEAD: FROM BELOW GLENOID CAVITY

INSERTION

INTO OLECRANON PROCESS OF ULNA

ORIGIN

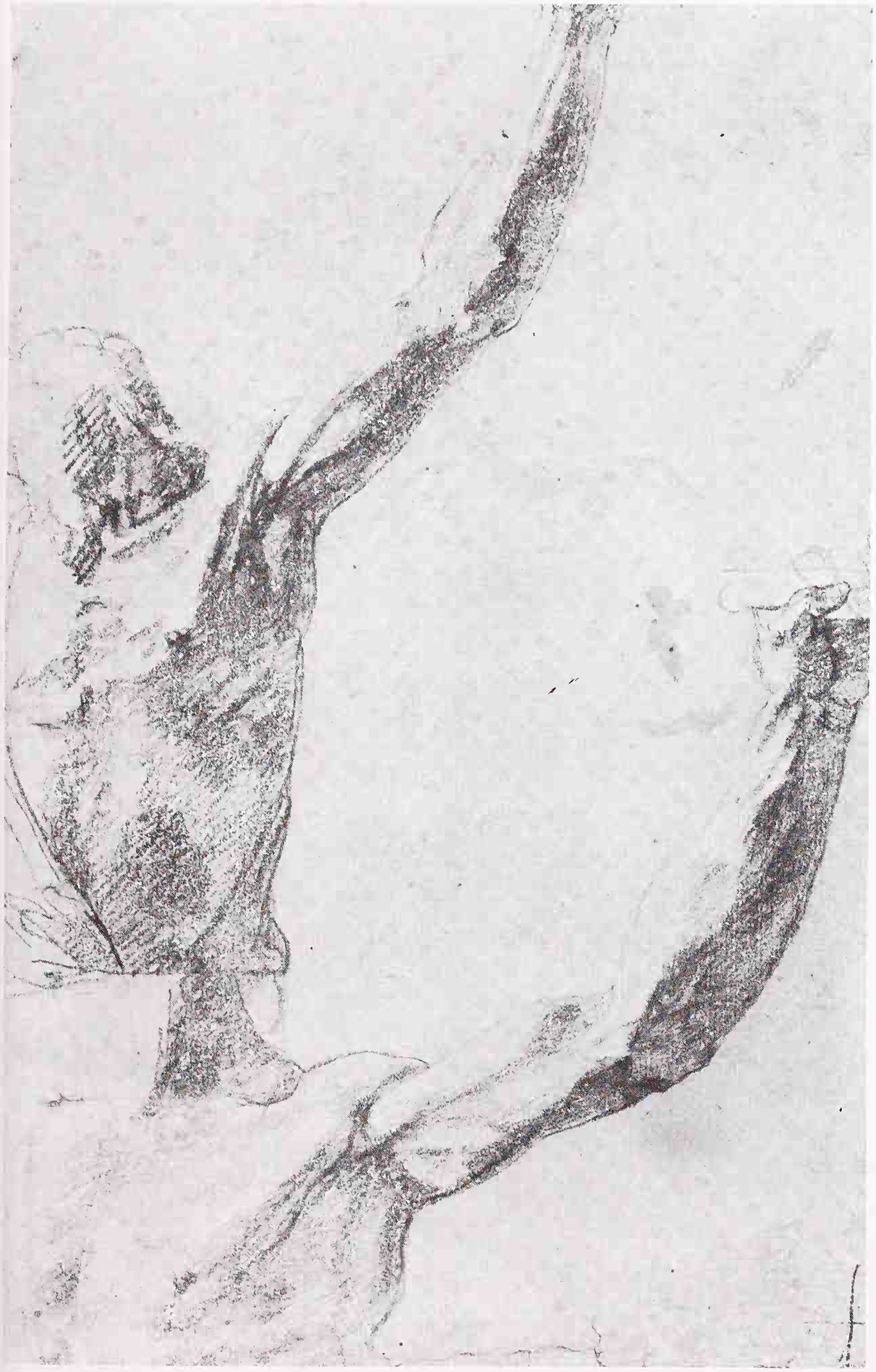
FROM EXTERNAL EPICONDYLE OF HUMERUS

INSERTION

INTO OUTER SIDE OF UPPER FOURTH OF SHAFT OF ULNA

TRICEPS

ANCONEUS



6-7

6-4

The Biceps Muscle, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The action of the biceps is to flex the arm and supinate the forearm.

6-5

Muscles of the Right Shoulder and Arm, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

6-6

Triceps.

The action of the triceps is to extend the arm when it is bent. It acts in opposition to the biceps and the brachialis muscles.

6-7

Two Studies of a Raised Arm by Polidoro da Caravaggio. (Courtesy: Trustees of the British Museum).

The lower study of the extended raised arm shows the spatial architecture of this form with a consistent perspective of related parallels running through the length of the forms, and across the form at right angles. Observe the parallel movements of tone across the biceps at either end of this muscle.

6-8

Study of an Arm (crayon) by the author. (Photograph by Kalman Zabarsky.)

In the raised arm, the biceps muscle departs from the overall axis from the shoulder to the elbow. A cross-tension from the tendon of the short head *(A)* at the coracoid process of the scapula to the radial insertion *(B)* bicipital tuberosity causes this movement. It should be carefully noted.

6-9

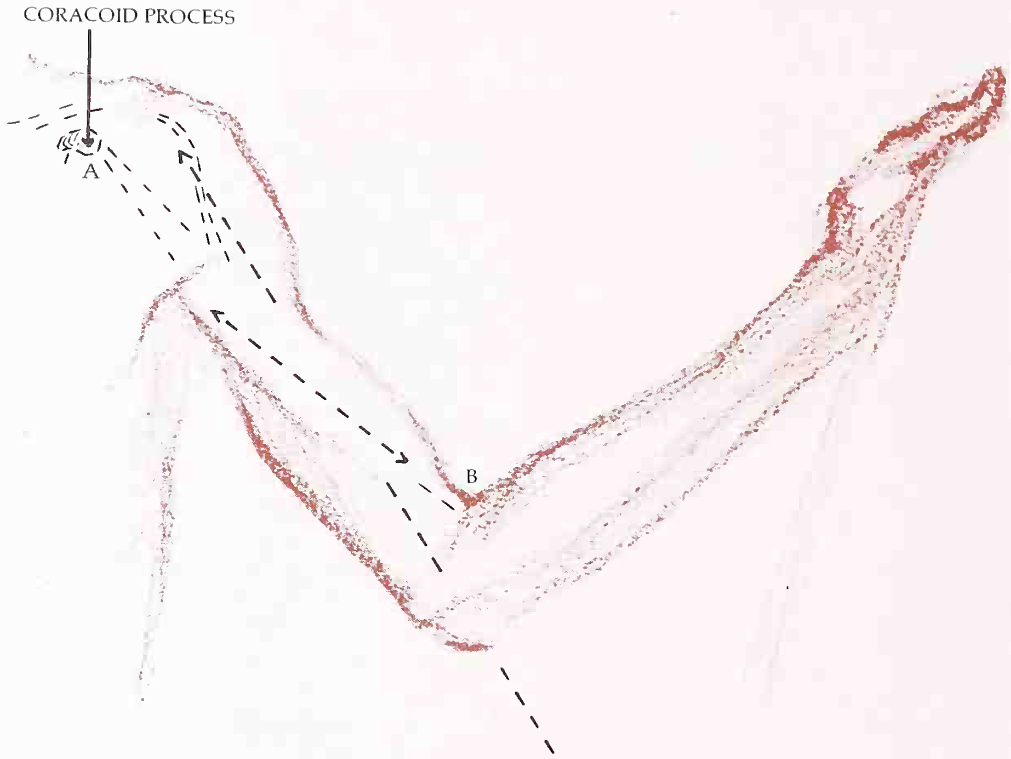
Muscles in the Raised Arm, from Anatomie of the External Forms of Man by Julian Fau. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

Compare this muscle drawing with the studies by Michelangelo [6-10].

6-10

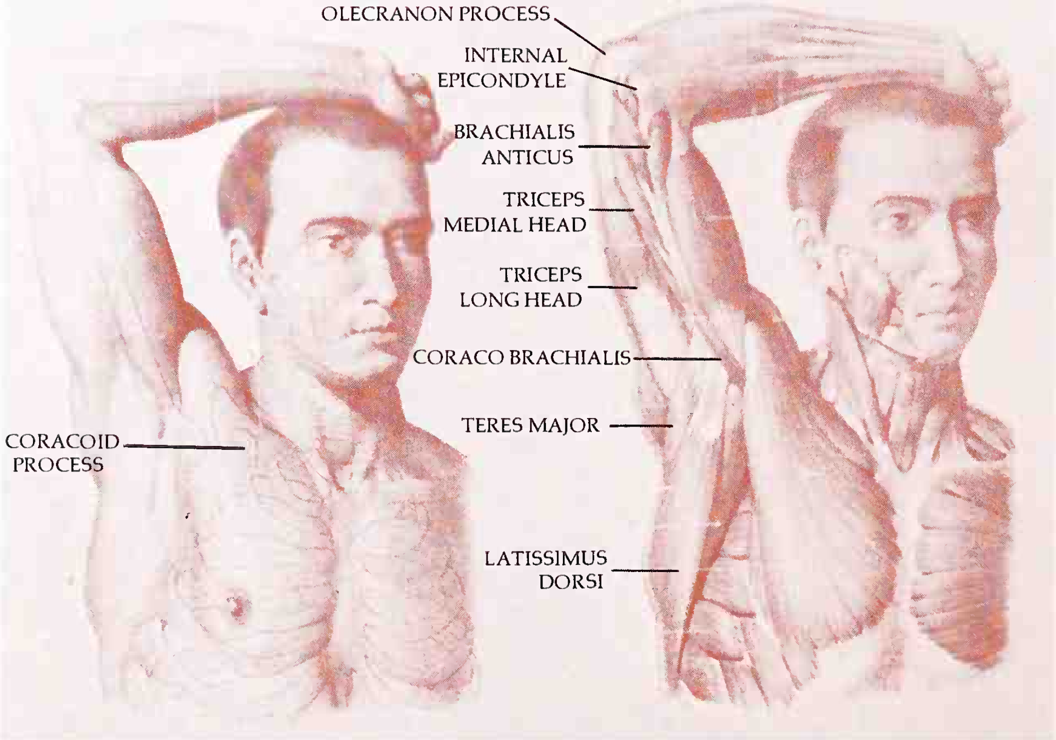
Studies of a Raised Arm by Michelangelo. (Musée Atger, Montpellier. Photograph by Charles O' Sughrue.)

In this informative drawing Michelangelo has carefully identified important surface anatomy. Beginning at his signature on the left and reading up are the following muscles *(A)* latissimus dorsi; *(B)* teres major; *(T)* triceps (long head); *(V)* triceps (medial head); *(Z)* inner epicondyle of the humerus; *(8)* olecranon process of the ulna. Unidentified, but found between the deltoid and the teres major, is the coracoid brachialis. In the upper left corner is another view showing the teres major *(B)*.

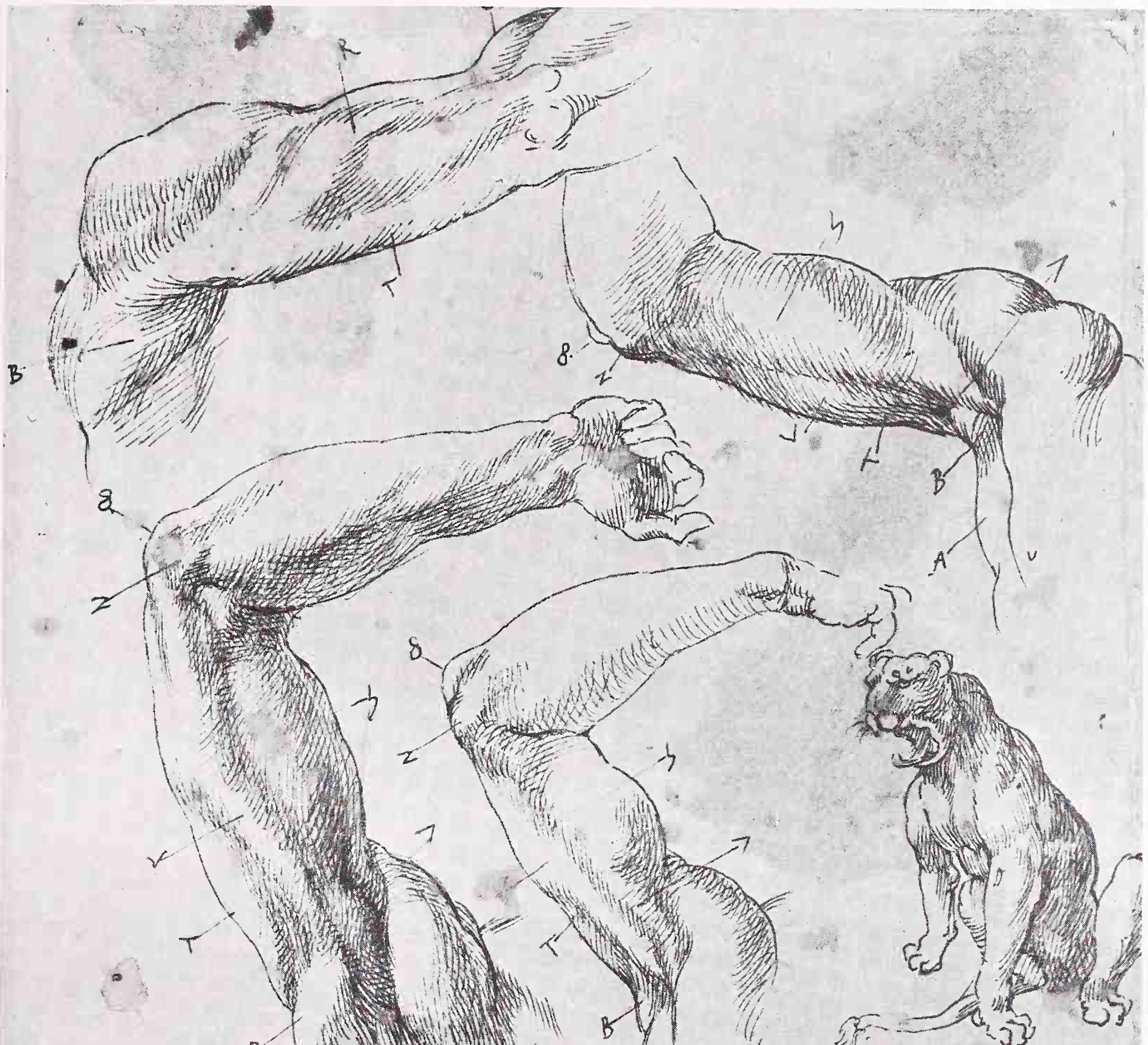

CORACOID PROCESS
A
B

6-8

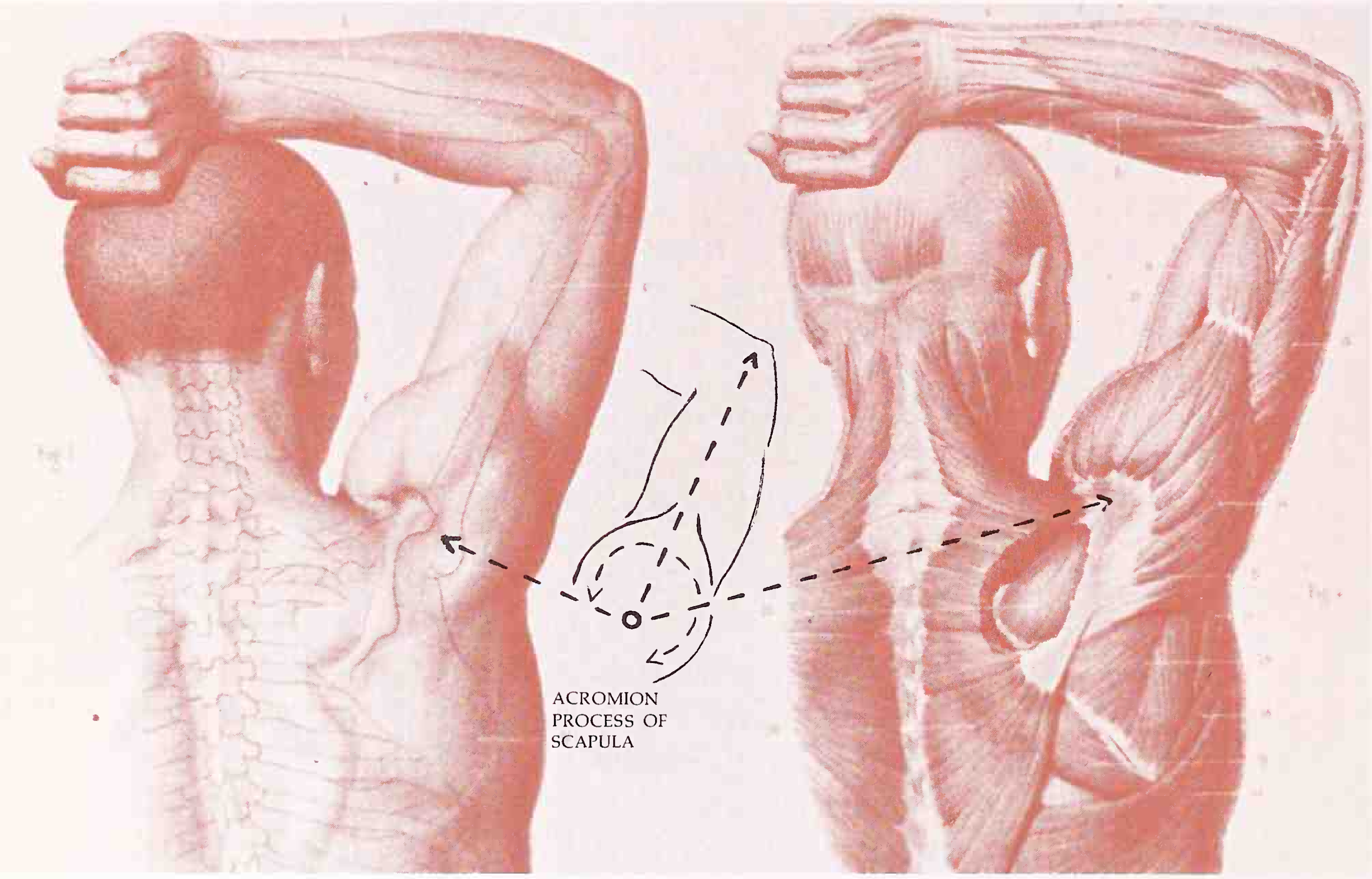
6-9


OLECRANON PROCESS
INTERNAL EPICONDYLE
BRACHIALIS ANTICUS
TRICEPS MEDIAL HEAD
TRICEPS LONG HEAD
CORACO BRACHIALIS
TERES MAJOR
CORACOID PROCESS
LATISSIMUS DORSI

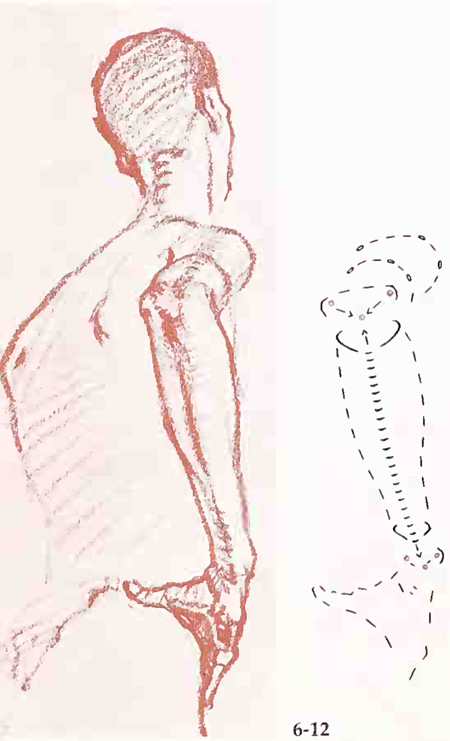
In the partially extended arm (palm up), the biceps muscle does not follow the humeral axis precisely. The origin of the long head of the biceps above the glenoid cavity of the scapula passes over the head of the humerus. The origin of the short head at the coracoid process of the scapula and its insertion at the bicipital tuberosity of the radius induces a diagonal tension from the armpit to the outer side of the elbow and gives a distinctive thrust to the biceps [6-8].


michelangelo

6-10



6-11



6-12

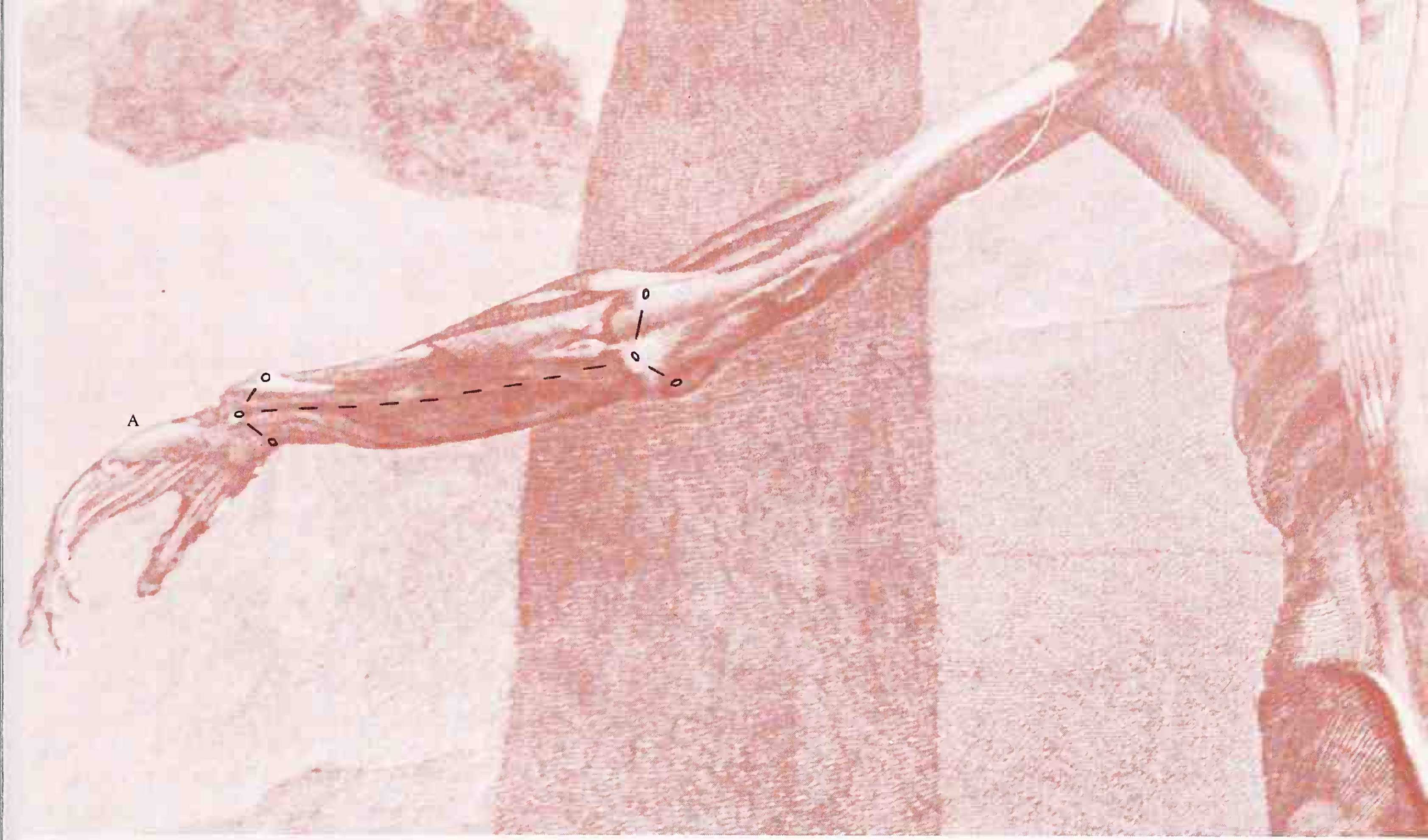
6-11
Muscles of the Raised Arm: Back View, from Anatomie of the External Forms of Man by Julian Fau. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

A visible point for the axis of the volume in the raised upper arm is the acromion process of the spine of the scapula. The deltoid muscle encircles the shoulder articulation from front to back and forms a curved volume around this depressed pivotal attachment. A portion of the triceps has been removed to reveal the supraspinatus muscle *(A)* above the spine of the scapula.

6-12
Analysis of the Structure of the Forearm. (Photograph by Jonathan Goell.)

The V-shaped alignment of bones at the elbow is repeated by muscle and bone at the wrist to provide the basis of form structure. (See illustration 6-13.)

From the back [6-5], the tendon of the triceps presents an unbroken, rather flat plane that passes over the elbow joint and inserts into the olecranon process of the ulna. The three padded heads of the triceps have the following points of origin: (1) the scapular (middle) head below the glenoid cavity of the scapula; (2) the external head at the rear of the humerus above the deltoid eminence; (3) the internal head at the lower rear surface of the humerus beneath the tendon [6-5, 6-6].



6-13

The hanging, relaxed arm presents directions and contour relationships that should be carefully noted. The vertically suspended upper arm changes at the elbow [6-12] to an outward diagonal thrust of the forearm away from the torso, most apparent when the palm faces forward. The spoollike diagonal trochlea (at the lower end of the humerus) sets the diagonal angle of the ulna bone at this articulation (see illustrations 6-1, 6-2, and 6-16).

At the elbow, when the arm is bent (for example, when the hand rests on the hip), a triangular relationship of bony eminences occurs. This V-shaped alignment [6-12, 6-13] is formed by the two epicondyles of the humerus and the olecranon process of the ulna bone. The arrangement is the origin of opposing planes that undergo considerable modification as they extend toward the wrist [6-12]. The muscular, rounded, upper forearm gives way to a bony and tendinous length, more blocklike in structure as it approaches the wrist and hand.

In drawing, the interconnectedness of muscles between the upper arm and the forearm is often compromised by overemphasizing linear creases at the inner side of the arm at the elbow. These creases can mistakenly be accepted as the end of a muscle and may interrupt the continuity of the fleshy extensor muscles (dominated by the supinator longus) as they insert between the brachialis anticus and triceps above the elbow. Linear creases and folds of flesh in many parts of the figure distort the organic continuity of muscle structure and demand careful scrutiny. In general, it is advisable not to stress these folds and creases of flesh [6-11].

The tension and interconnectedness of muscles in action is difficult to combine with the spatial existence of forms. No artist resolved this complex interdependence more successfully than Michelangelo. His mastery of straining muscle movement, synthesized into foreshortened spatial figure structures in every conceivable attitude, is unique in its understanding, authority, and expressive power (see illustrations 6-10, 6-36, and 6-42).

6-13

Detail of the Arm, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The structure of the forearm in pronation (palm down) is shown. The position of the epicondyles and olecranon process at the elbow provides the basis for a structure of surfaces ending in a related sequence at the wrist. The flexor brevis minimi digiti *(A)* of the hand is shown in relation to the wrist.

THE FOREARM

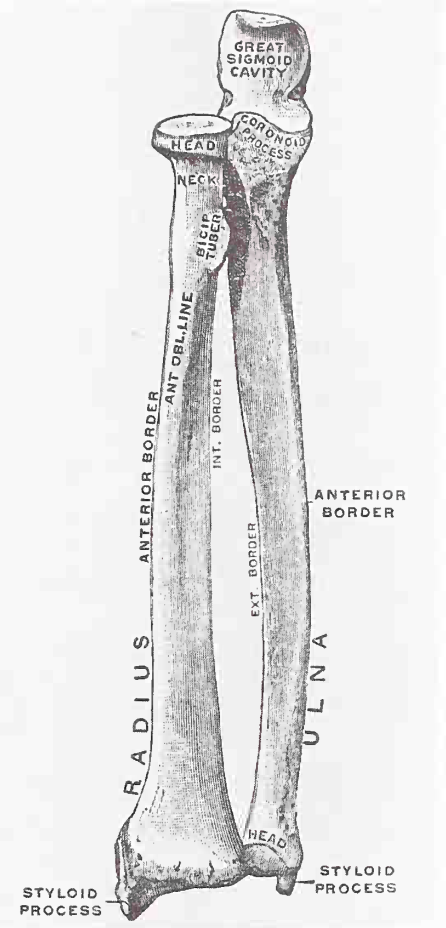
The muscles of the forearm are numerous and difficult to visualize. They have a variety of functions—extending and flexing the arm, turning the radius bone on its ulna axis, bending the hand at the wrist, and controlling the movement of the fingers and their individual digits. These are frequently combined actions and employ many muscles, continually transforming the shape of this extremity. The forearm presents itself conveniently for direct examination. The reader may wish to make immediate reference to his own arm as he studies this section of the text. It has been developed with this intention, using the right forearm (to be compared with illustrations 6-31 and 6-32).

The muscles will be considered in three major groups as form, but they are functionally either flexors or extensors. (The flexors of the forearm bend the fingers into the palm in a gripping action; the extensors straighten the fingers. Related flexors bend the arm at the elbow and wrist.)

First, note the location of the two bones of the forearm. (Observe your own right arm as you read. Compare it with illustration 6-31 and then touch each point referred to—tactually and visually "X-ray" the form.) Viewing the forearm, palm up, the radius and ulna bones lie parallel from elbow to wrist. (The turning action of the radius and the movement of related muscles will be discussed later in this chapter in the section, The Rotation of the Radius.) The radius is on the thumb side; the ulna aligns with the little finger. The ulna bone can be felt along its entire length by running the fingers of the left hand from the point of the elbow (the olecranon process of the ulna) along the exposed shaft to the knob of bone just above the wrist (above the styloid process of the ulna). This clearly identifiable shaft of bone divides two important groups of muscles [6-32]. Above the ulna, on the palmar side of the forearm, are the flexor muscles fanning out across the inner arm from a common origin at the internal epicondyle of the humerus. The condylar prominence can be felt on the inner side just above the point of the elbow.

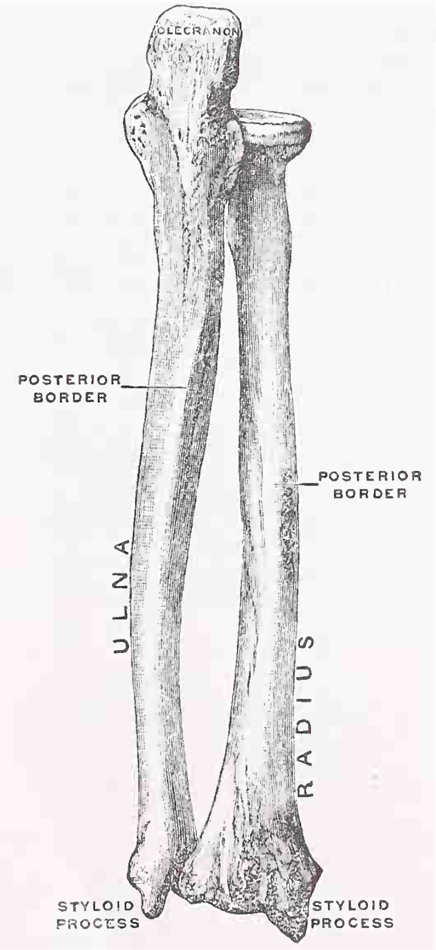
The flexor muscles [6-31]—all with a common origin at the internal epicondyle of the humerus—are: (1) the flexor carpi ulnaris (lies directly along the shaft of the ulna bone and inserts by tendon into the pisiform bone of the wrist or carpus); (2) the palmaris longus (fans out from its tendon into the surface of the palm of the hand); (3) the flexor carpi radialis (inserts into the base of the metacarpal bone of the index finger); (4) the pronator radii teres (a short muscle that inserts into the outer margin at mid-shaft of the radius). The deeper muscles of this group are the flexor digitorum sublimus and the flexor pollicis longus [6-29].

Continuing the direct examination of the right forearm, palm up, with the forearm slightly bent and tensed, place the left index finger in the slight depression at the inner side of the arm at the elbow articulation. Firm pressure at this point, while tensing the arm, will identify the biceps tendon (inserting at the bicipital tuberosity of radius).



6-14

6-15



6-14
The Radius and the Ulna (Right Forearm): Front View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

6-15
The Radius and the Ulna (Right Forearm): Rear View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

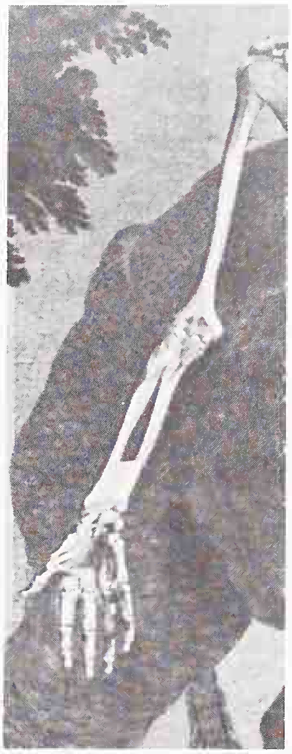
6-16

Detail of Bones of the Arm, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

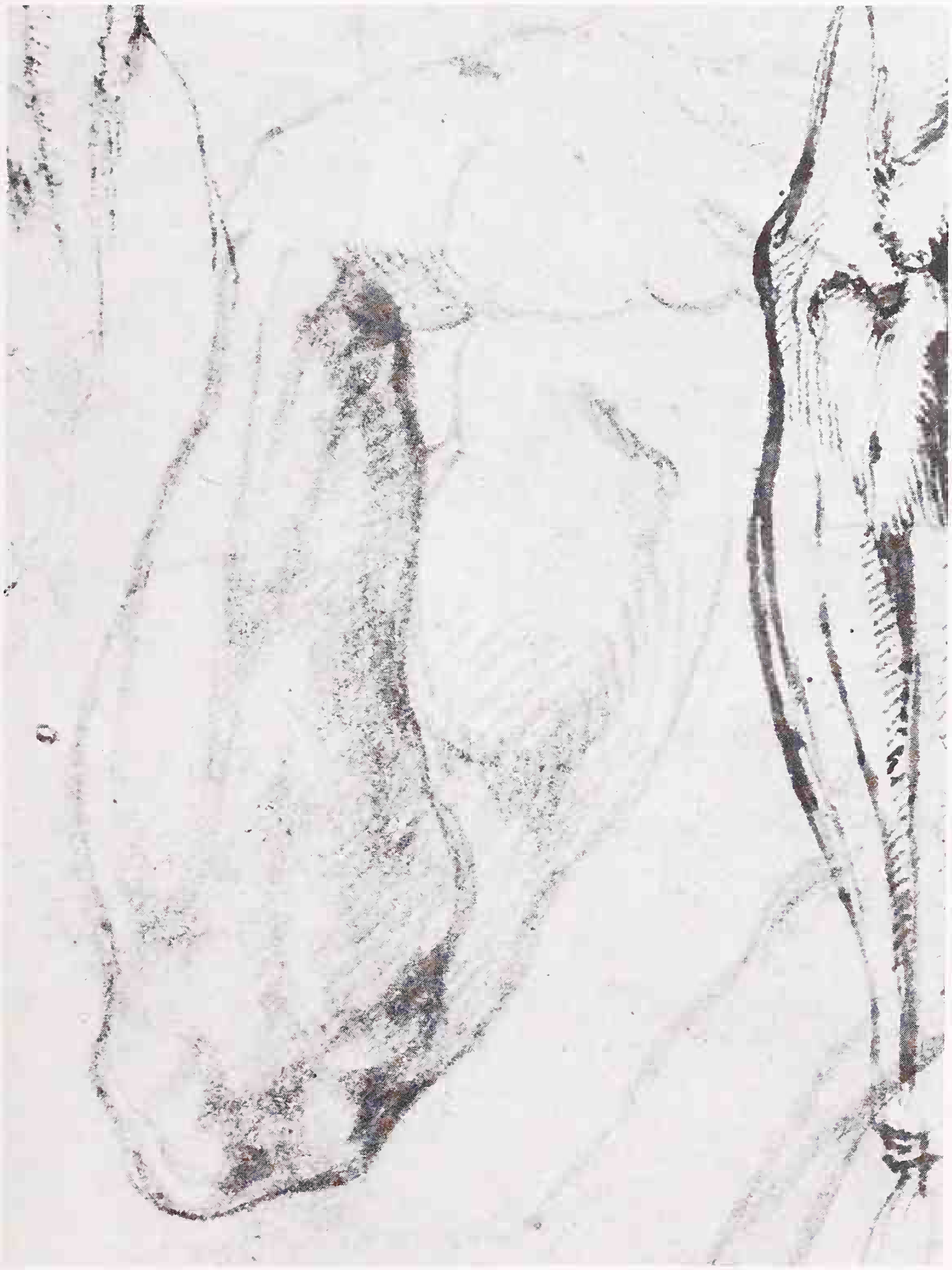
6-17

Forearm Detail from Studies of Arms and Hands by Michelangelo. (Teylers Stichting, Haarlem.)

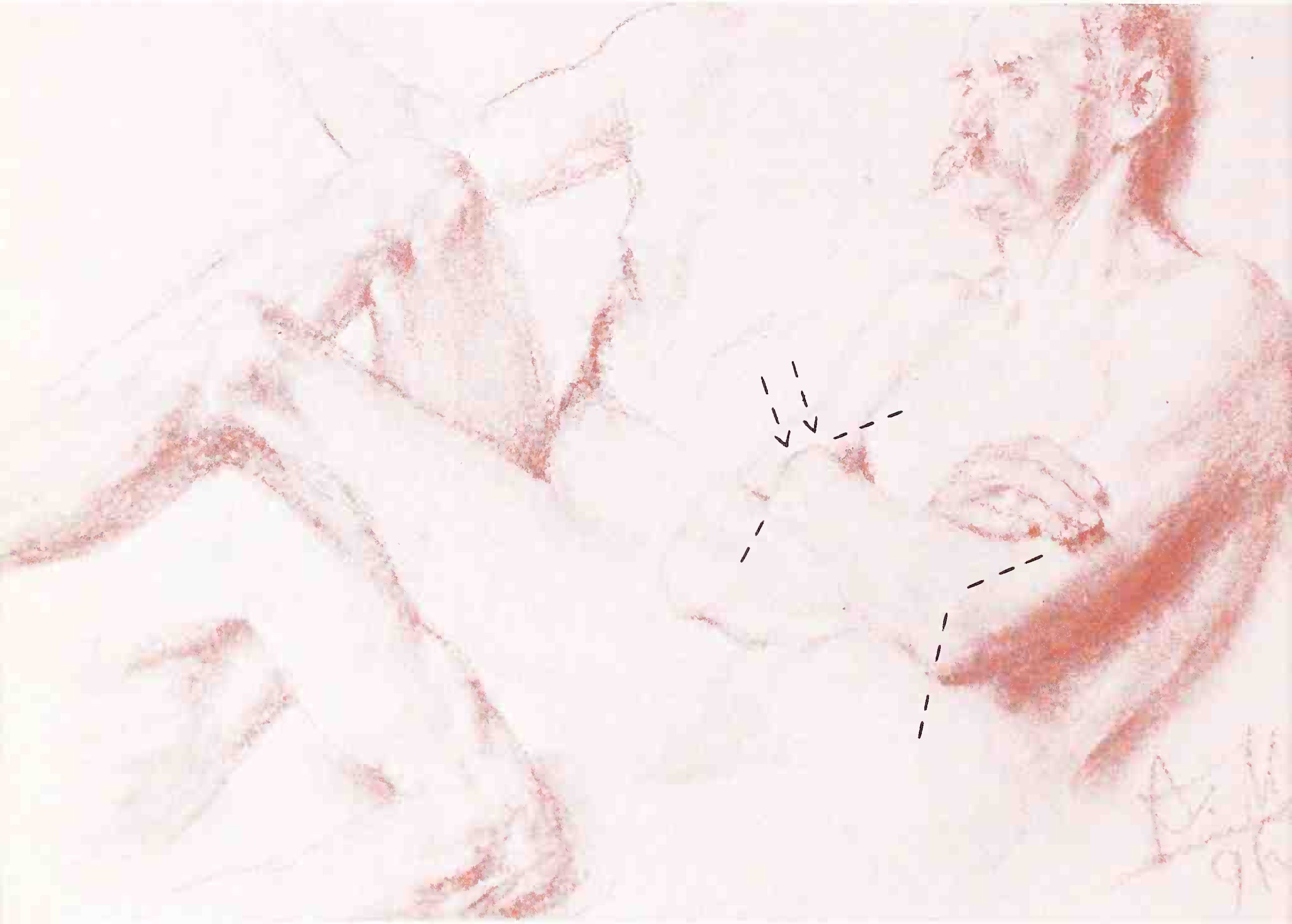
Running vertically through the center of the arm is the shaft of the ulna bone. It is clearly visible from the prominent elbow (olecranon process) to the rounded head of the ulna at the wrist. To the left of this bone is the long extensor carpi ulnaris (and related extensors). To the right of this shaft is the flexor carpi ulnaris (and related flexors). These two groups of muscles (flexors and extensors) are separated by the ulna.



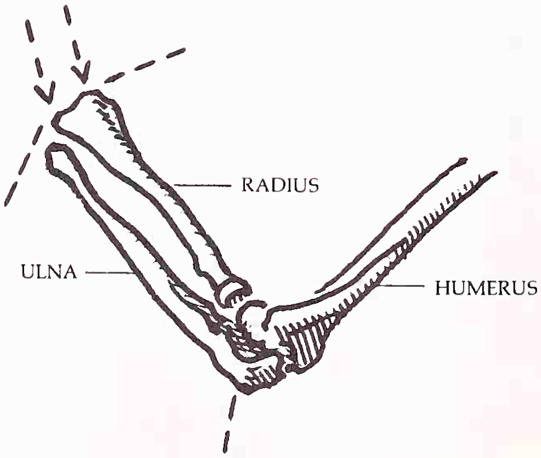
6-16



6-17



6-18



6-18

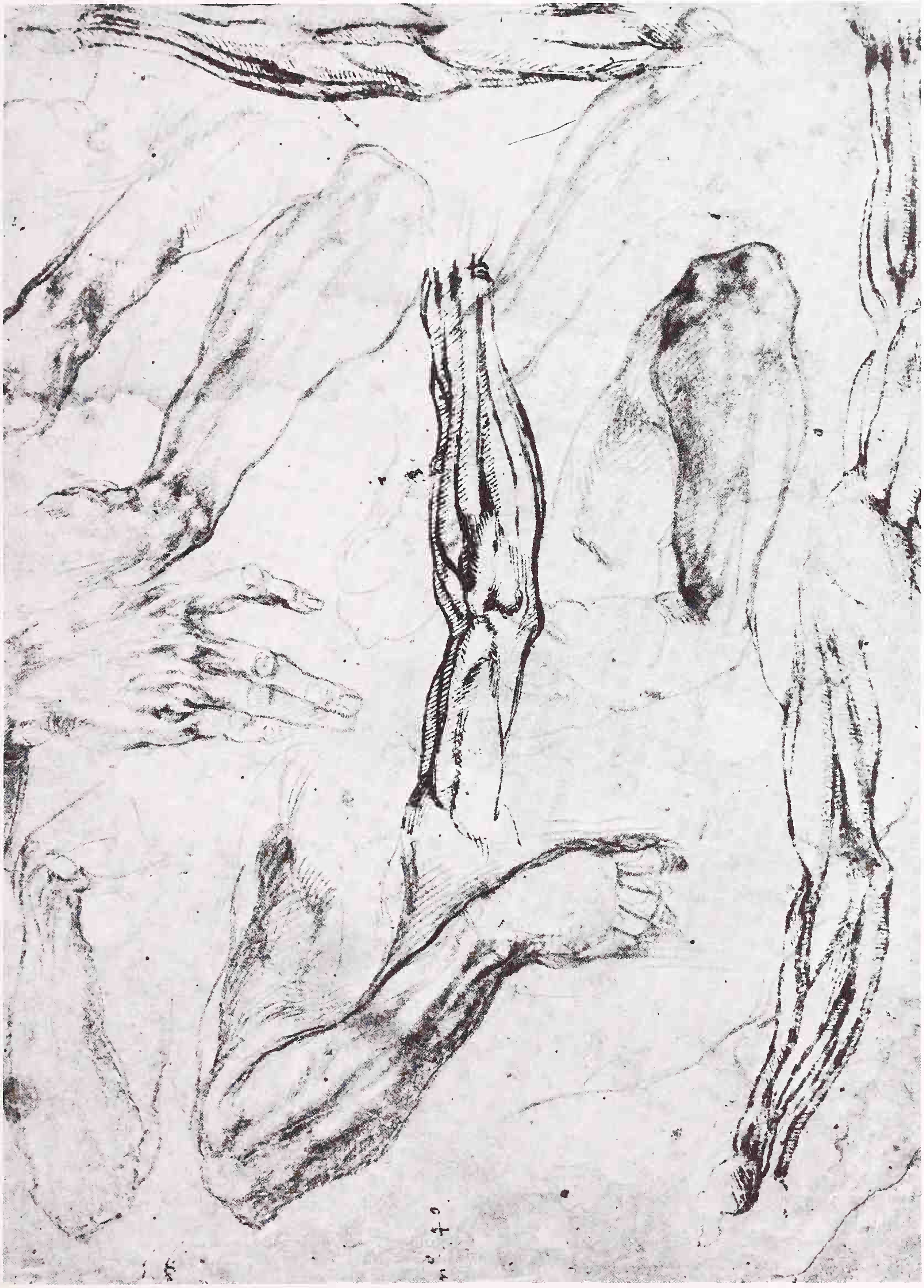
Anatomical Figure Studies by Adloph Menzel. (Collection: Mr. and Mrs. Irving M. Sobin, Boston. Photograph by Kalman Zabarsky.)

The change of planes just above the wrist in the forearm is set by the dimension of the radius (arrows) opposed to the lower position of the head of the ulna bone. This surface relationship is echoed at the elbow.

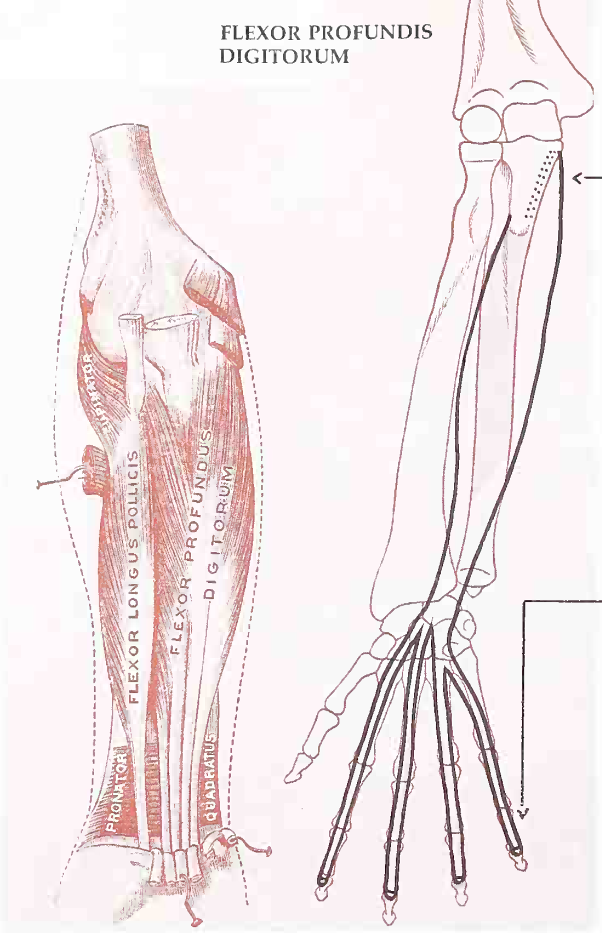
6-19

Studies of Arms and Hands by Michelangelo. (Teylers Stichting, Haarlem.)

This valuable page of studies reveals the artist's careful study of bone, muscle, and tendon. The raised forearm at the lower left shows the two epicondyles of the humerus on each side of the point of the elbow (the olecranon process of the ulna). The articulation of the wrist-space for its existence between hand and forearm is clear in other studies.



6-19


SUPINATOR
FLEXOR LONGUS POLLICIS
FLEXOR PROFUNDUS DIGITORUM
PRONATOR
QUADRATUS

FLEXOR PROFUNDIS DIGITORUM

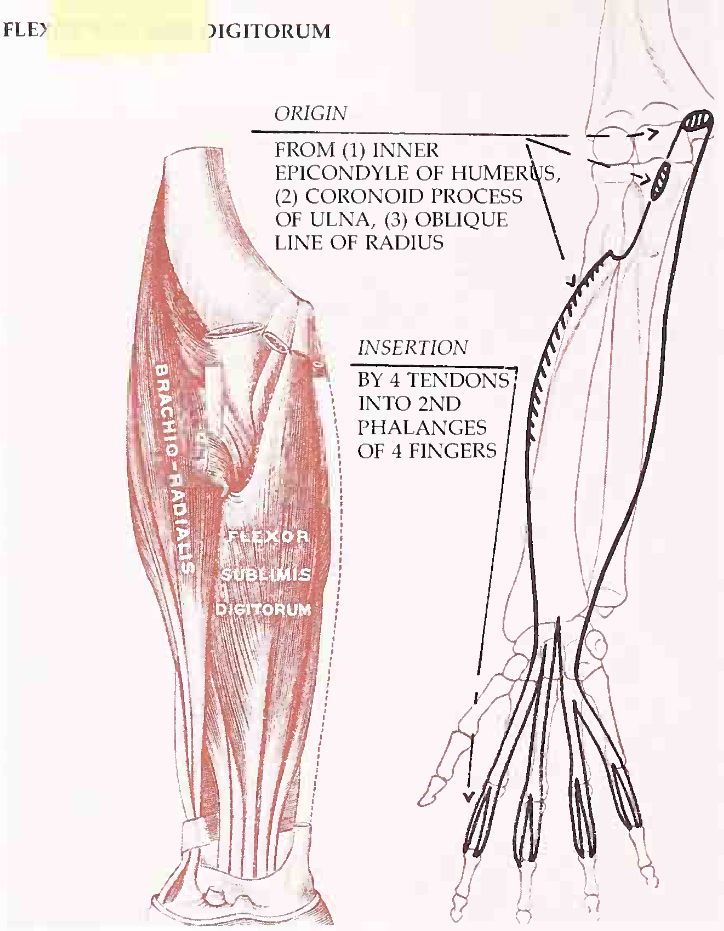
ORIGIN

FROM UPPER ¾ OF SHAFT OF ULNA

INSERTION

INTO BASE OF LAST 4 PHALANGES

6-20


BRACHIO-RADIALIS
FLEXOR SUBLIMIS DIGITORUM

FLEX [illegible] DIGITORUM

ORIGIN

FROM (1) INNER EPICONDYLE OF HUMERUS, (2) CORONOID PROCESS OF ULNA, (3) OBLIQUE LINE OF RADIUS

INSERTION

BY 4 TENDONS INTO 2ND PHALANGES OF 4 FINGERS

6-21

6-20

Common Deep Flexors of the Fingers, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The flexor profundis digitorum flexes four fingers.

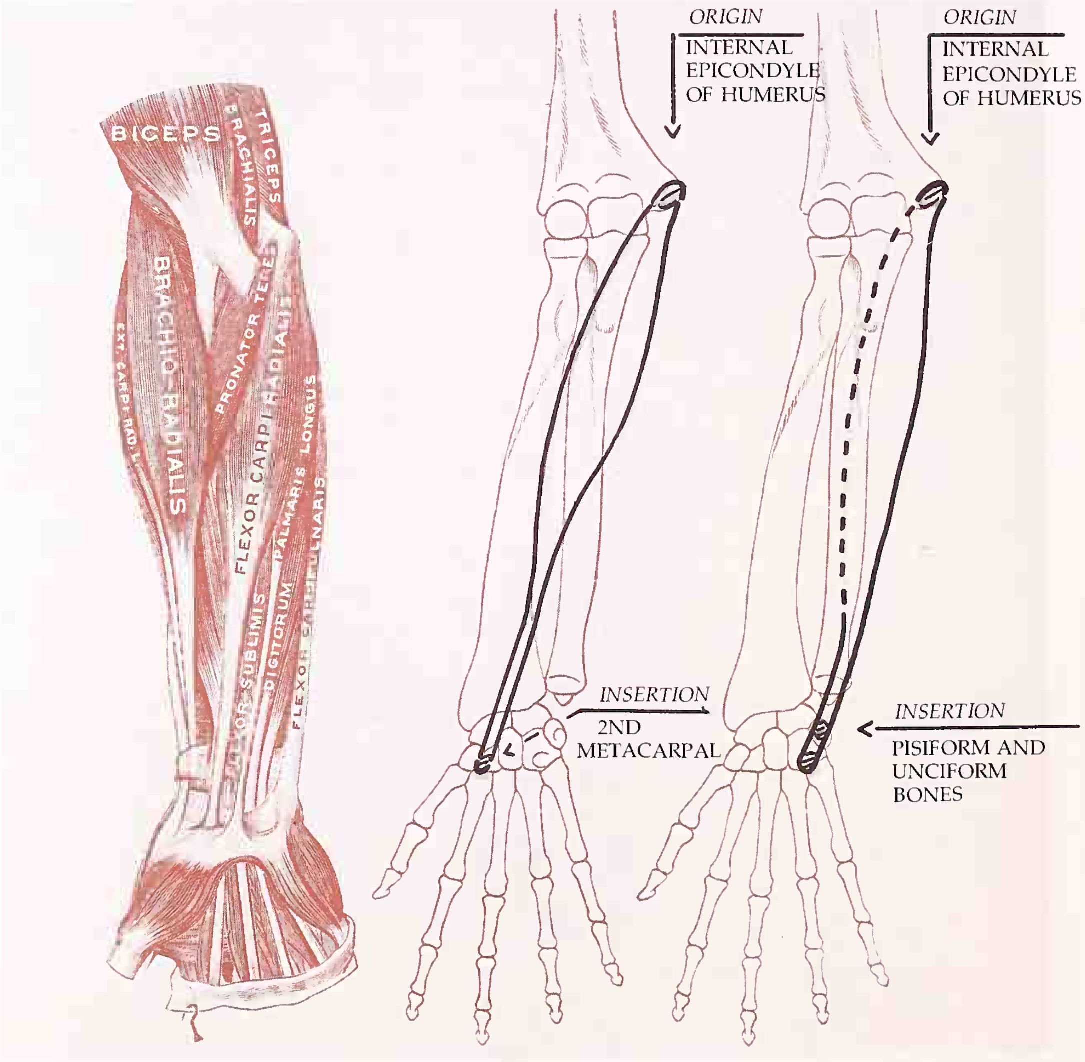
6-21

Flexors of the Fingers, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

6-22

Superficial Muscles: Right Front Forearm, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The flexor muscles have a common origin from the inner epicondyle of the humerus. The supinator longus supinates the hand (to palm up position). The flexor carpi radialis and the flexor carpi ulnaris flex the wrist.


BICEPS
TRICEPS
BRACHIALIS
BRACHIO-RADIALIS
EXT. CARPI RAD. L.
PRONATOR TERES
FLEXOR CARPI RADIALIS
PALMARIS LONGUS
FLEXOR CARPI ULNARIS
FLEXOR SUBLIMIS DIGITORUM

ORIGIN

INTERNAL EPICONDYLE OF HUMERUS

ORIGIN

INTERNAL EPICONDYLE OF HUMERUS

INSERTION

2ND METACARPAL

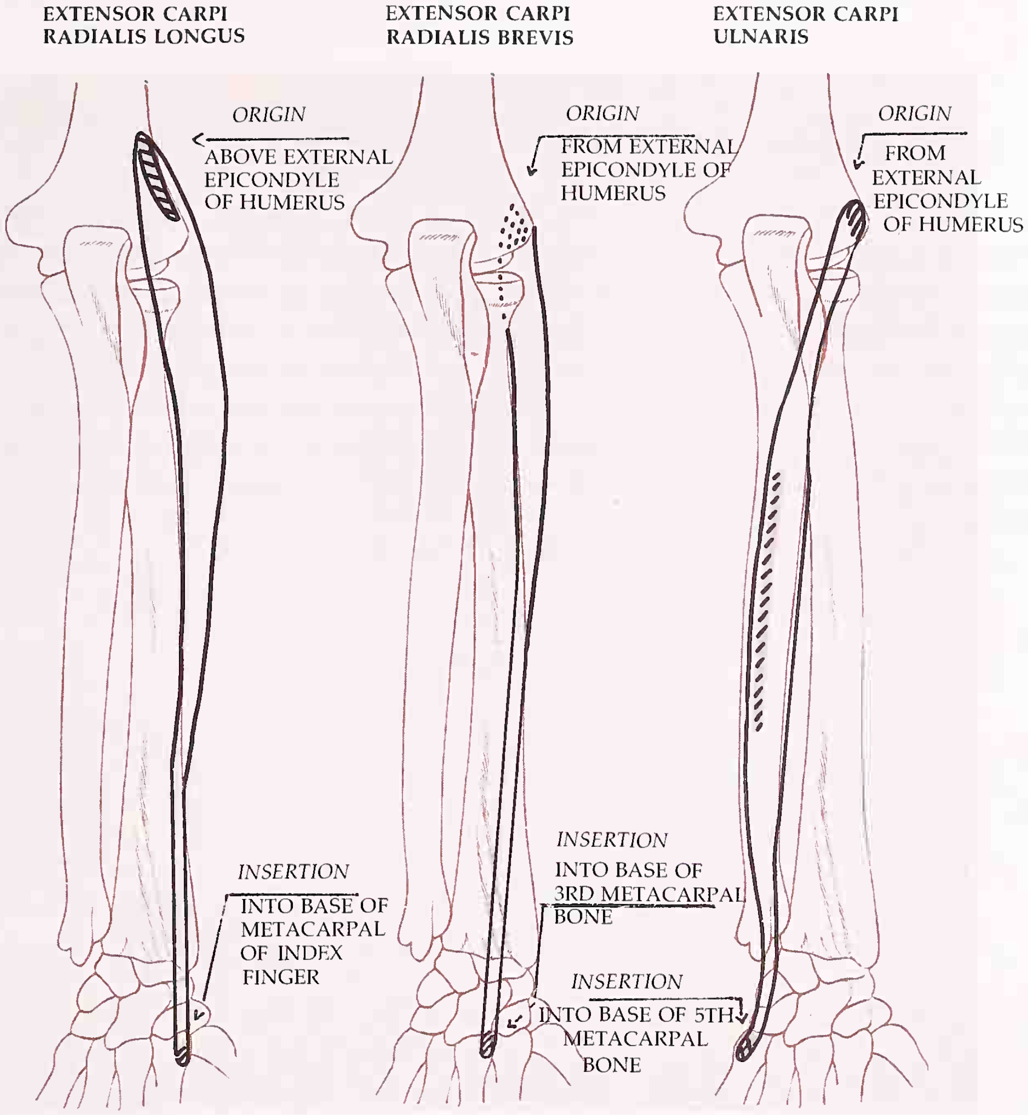
INSERTION

PISIFORM AND UNCIFORM BONES

6-22

FLEXOR CARPI RADIALIS

FLEXOR CARPI ULNARIS

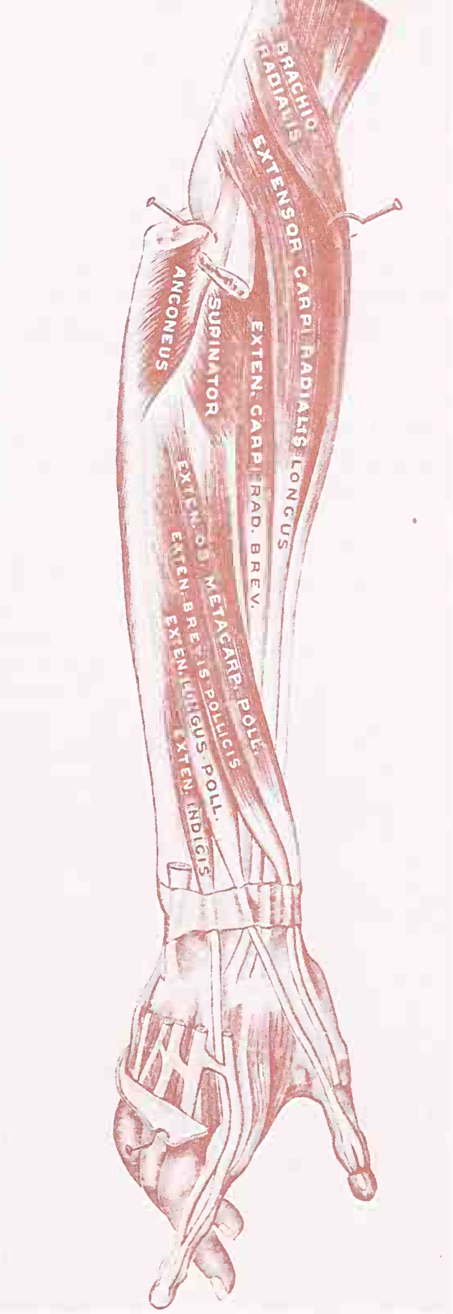

EXTENSOR CARPI RADIALIS LONGUS
EXTENSOR CARPI RADIALIS BREVIS
EXTENSOR CARPI ULNARIS
ORIGIN
ABOVE EXTERNAL EPICONDYLE OF HUMERUS
ORIGIN
FROM EXTERNAL EPICONDYLE OF HUMERUS
ORIGIN
FROM EXTERNAL EPICONDYLE OF HUMERUS
INSERTION
INTO BASE OF METACARPAL OF INDEX FINGER
INSERTION
INTO BASE OF 3RD METACARPAL BONE
INSERTION
INTO BASE OF 5TH METACARPAL BONE

6-24

To the right of the biceps tendon (the radial region), two strong and visually significant extensor muscles are located [6-23, 6-24]. Both originate from the outer ridge of the humerus bone, one above the other (at the lower third of the humerus, just above the external condyle). Above is the supinator longus (brachioradialis), inserting at the wrist into the styloid process of radius. Below is the extensor carpi radialis longus, inserting into the base of the metacarpal bone of the index finger. These two prominent muscles round out the upper forearm as they pass over the elbow articulation, and they extend the wrist and supinate the forearm, turning the palm of the hand forward.

The remaining five extensor muscles lie on the back side of the forearm and have a common origin at the external condyle of the humerus bone. (Two additional extensors will be covered separately.) Again with the palm up and returning to the shaft of the ulna, the first muscle encountered on its underside is the anconeus, a short superficial muscle inserting at the olecranon process (elbow) of the ulna [see 6-6]. (The anconeus should be mentioned but may be difficult to locate.) Emerging beneath this muscle and extending the length of the shaft of the ulna (from a common origin at the external epicondyle) is the extensor carpi ulnaris (which inserts at the outer side of the metacarpal of the little finger).

The following muscles proceed in sequence to the radial (thumb) side of the arm: the extensor minimi digiti (inserts into the last two digits of the little finger); the extensor communis digitorum (each of its four separate tendons inserts into the last two digits of the four fingers); the extensor carpi radialis brevis (inserts at the base of the third metacarpal of the middle finger). This last muscle lies under the previously mentioned extensor carpi radialis longus [6-23].


BRACHIO RADIALIS
EXTENSOR CARPI RADIALIS LONGUS
ANCONEUS
SUPINATOR
EXTEN. CARPI RAD. BREV.
EXTEN. OS METACARP. POLL.
EXTEN. BREVIS POLLICIS
EXTEN. LONGUS POLL.
EXTEN. INDICIS

6-23

Deeper Extensors of the Forearm, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

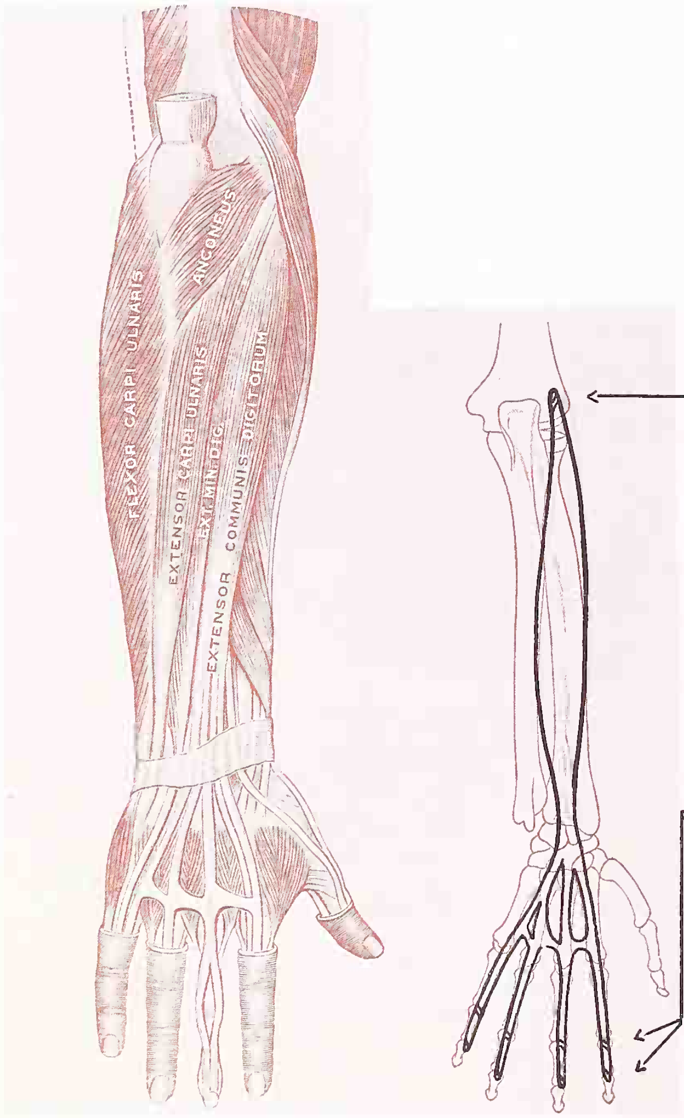
The deeper extensor muscles of the forearm extend the fingers and the wrist.

6-24

Extensors of the Wrist.

The extensor carpi radialis longus, the extensor carpi radialis brevis, and the extensor carpi ulnaris all extend the wrist.

The pollicis (thumb) muscles are exposed as a group above the wrist on the radial (thumb) side of the lower forearm and activate the bones of the thumb [6-28, 6-29]. The abductor pollicis longus has its origin at the mid-rear surface of the shaft of the ulna and diagonally across the lower third of the radius. It inserts at the base of the metacarpal of the thumb. The extensor pollicis brevis (which lies under the abductor pollicis longus) has its origin at the rear lower third of the radius, and its insertion is at the base of the first digit of the thumb. (An additional muscle articulates the last digit of the thumb and is visible only as a tendon—the fibers of this muscle, the extensor pollicis longus, lie deep against the ulna.)



ORIGIN

FROM THE INNER
EPICONDYLE OF
THE HUMERUS

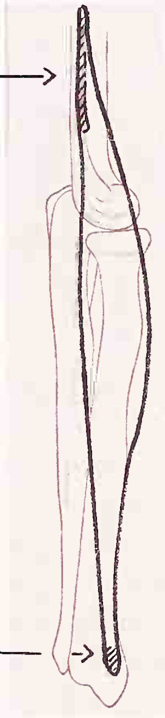
INSERTION

INTO THE 2ND AND
3RD PHALANGES (DIGITS)
OF THE 4 FINGERS
OF SEPARATE TENDONS
FROM THE COMMON
EXTENSOR

6-25

6-25
Superficial Extensor Muscles of the Forearm: Dorsal View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The extensor communis digitorum extends the fingers.



ORIGIN

FROM THE LATERAL
RIDGE ABOVE THE
CONDYLE OF THE
HUMERUS

INSERTION

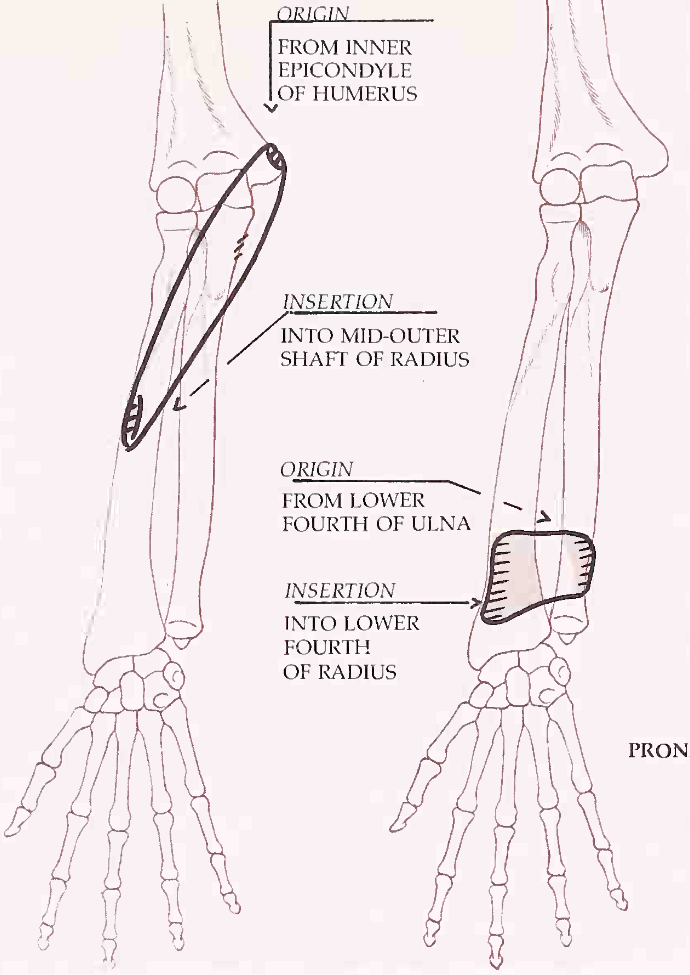
INTO THE BASE OF
THE STYLOID PROCESS
OF THE RADIUS

6-26

6-26
Supinator Longus (Brachioradialis).

This muscle turns the forearm to the palm up position.

6-27


ORIGIN
FROM INNER EPICONDYLE OF HUMERUS
INSERTION
INTO MID-OUTER SHAFT OF RADIUS
ORIGIN
FROM LOWER FOURTH OF ULNA
INSERTION
INTO LOWER FOURTH OF RADIUS

PRONATOR TERES

PRONATOR QUADRATUS

6-27
The Pronators of the Forearm.

The pronators turn the palm of the hand down from palm up position.

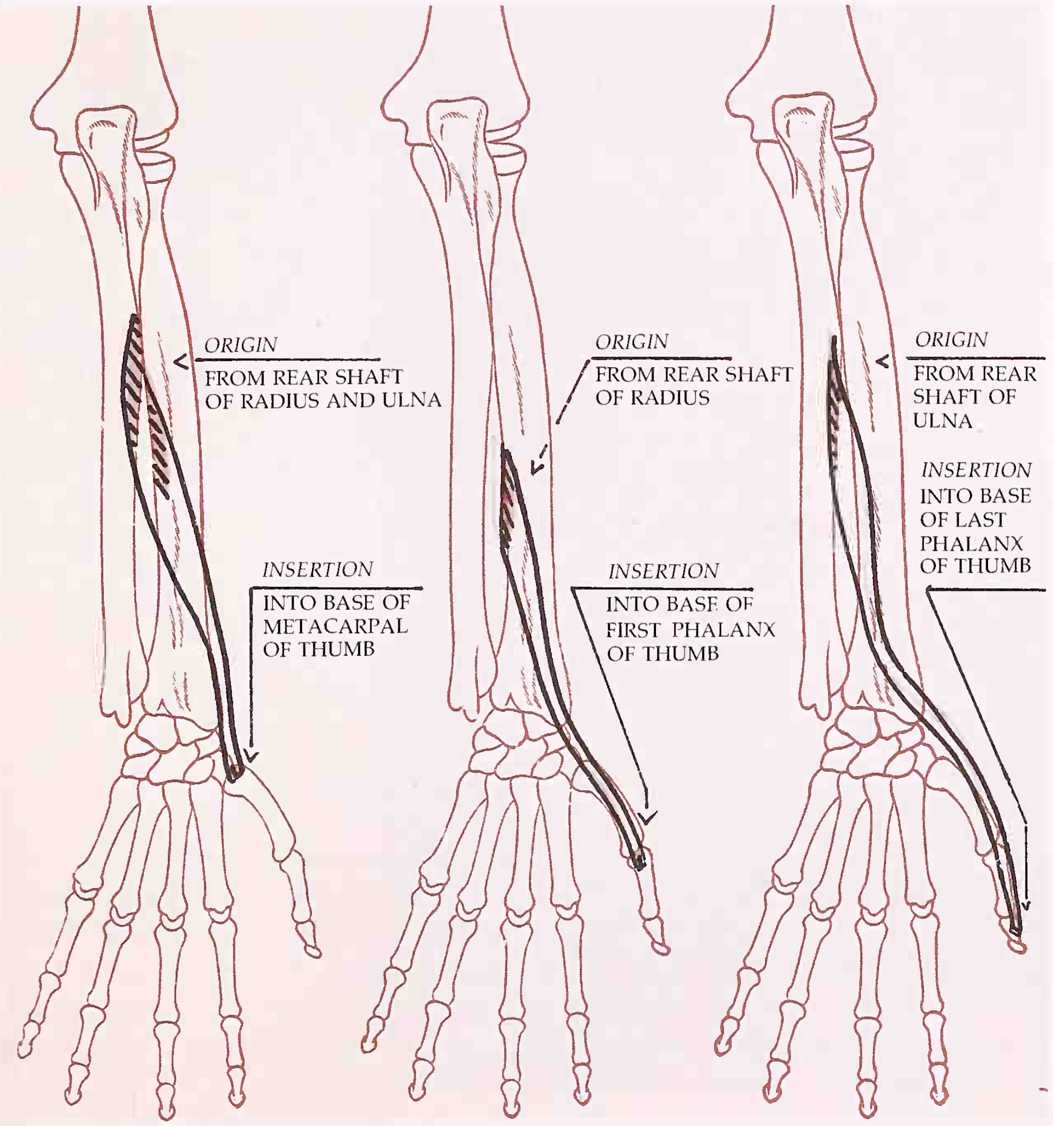
6-28
Extensors of the Thumb.

These muscles extend the metacarpal and the digits of the thumb.

6-29
Flexor of the Thumb.

The flexor pollicis longus flexes the thumb.

6-28

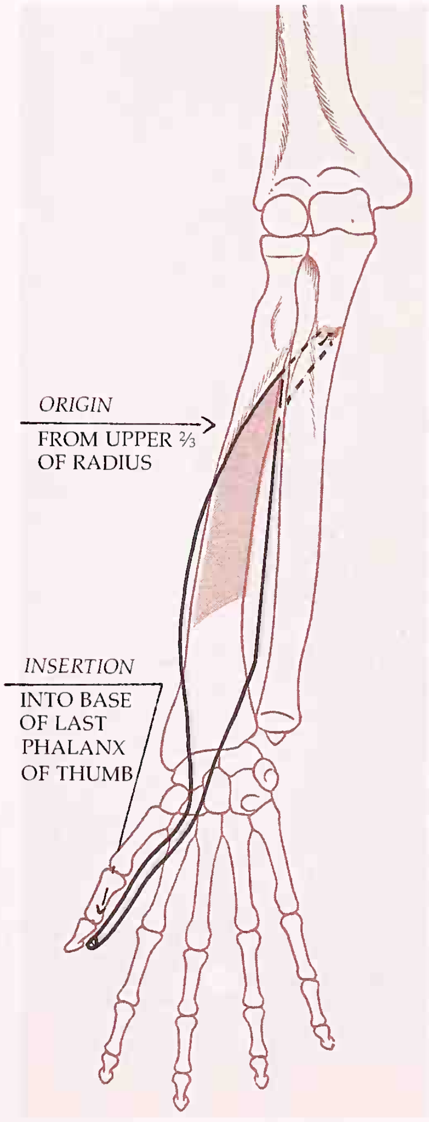

ORIGIN
FROM REAR SHAFT OF RADIUS AND ULNA
INSERTION
INTO BASE OF METACARPAL OF THUMB
ORIGIN
FROM REAR SHAFT OF RADIUS
INSERTION
INTO BASE OF FIRST PHALANX OF THUMB
ORIGIN
FROM REAR SHAFT OF ULNA
INSERTION
INTO BASE OF LAST PHALANX OF THUMB

EXTENSOR OSSIS METACARPI POLLICIS

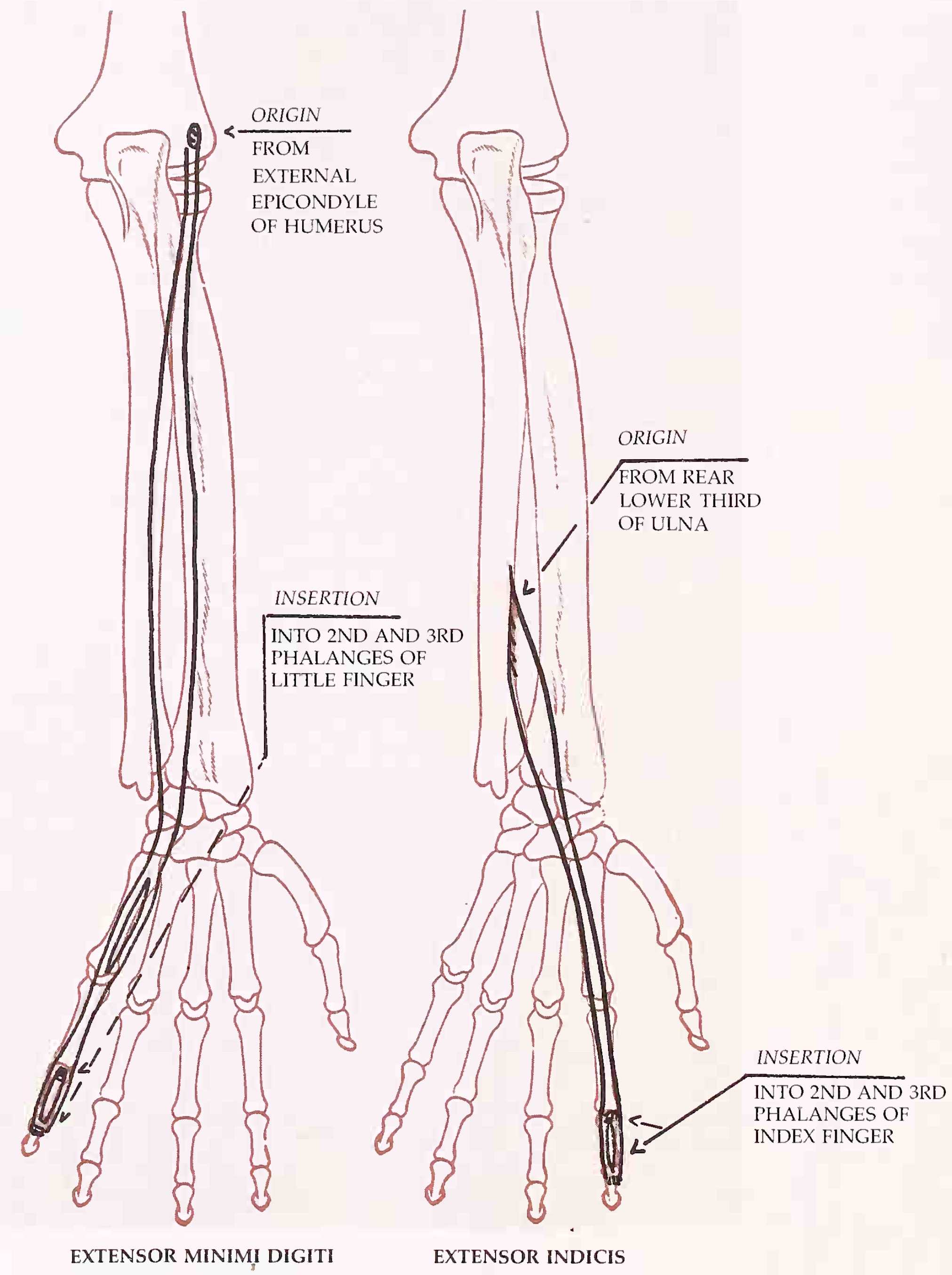
EXTENSOR POLLICIS BREVIS

EXTENSOR POLLICIS LONGUS

6-29


ORIGIN
FROM UPPER ⅔ OF RADIUS
INSERTION
INTO BASE OF LAST PHALANX OF THUMB

6-30


ORIGIN
FROM EXTERNAL EPICONDYLE OF HUMERUS
INSERTION
INTO 2ND AND 3RD PHALANGES OF LITTLE FINGER
ORIGIN
FROM REAR LOWER THIRD OF ULNA
INSERTION
INTO 2ND AND 3RD PHALANGES OF INDEX FINGER
EXTENSOR MINIMI DIGITI
EXTENSOR INDICIS

6-30
Extensors of the Index Finger and the Little Finger.

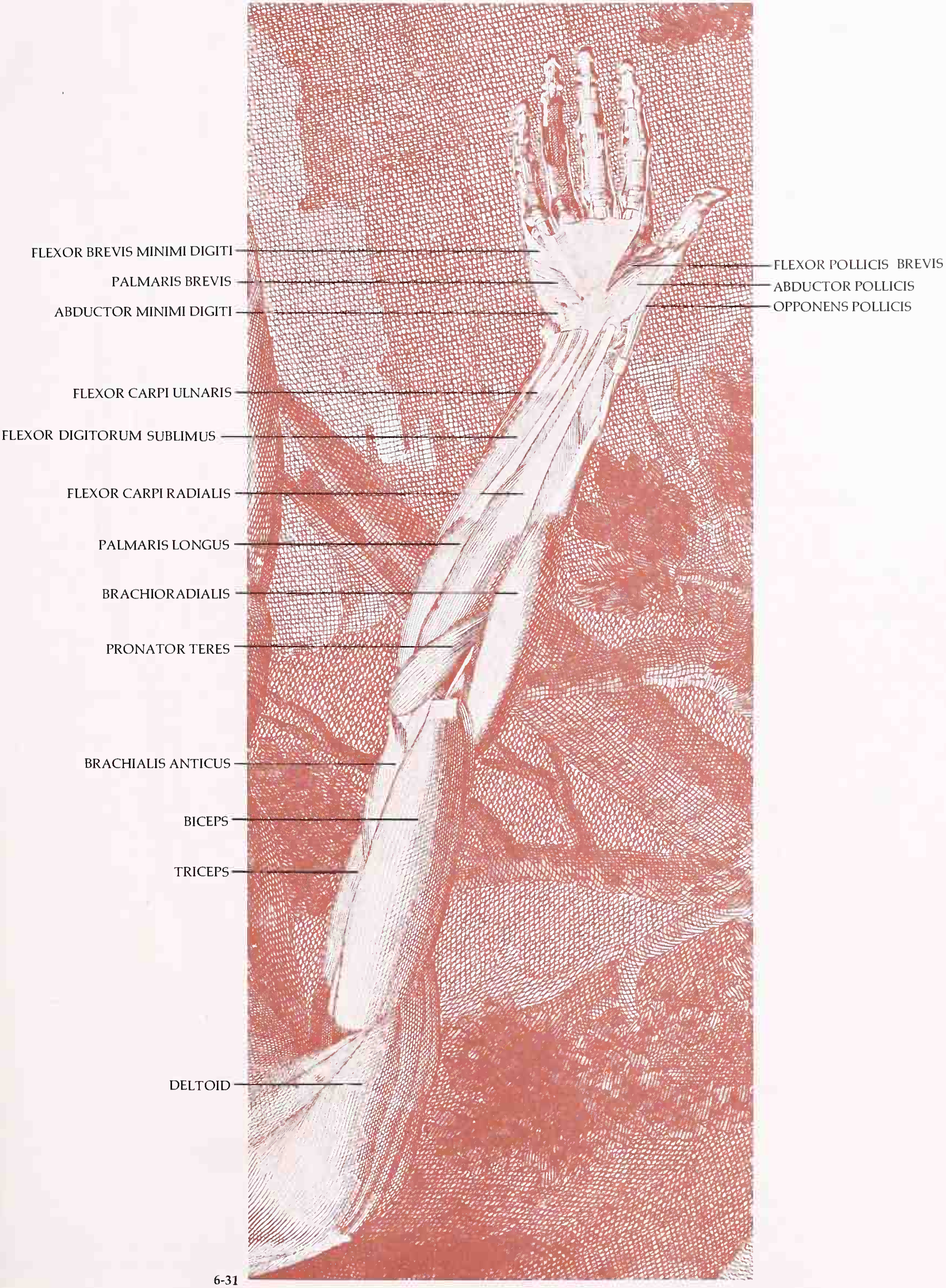
The extensor indicis extends the index finger. The extensor minimi digiti extends the little finger.

THE ROTATION OF THE RADIUS

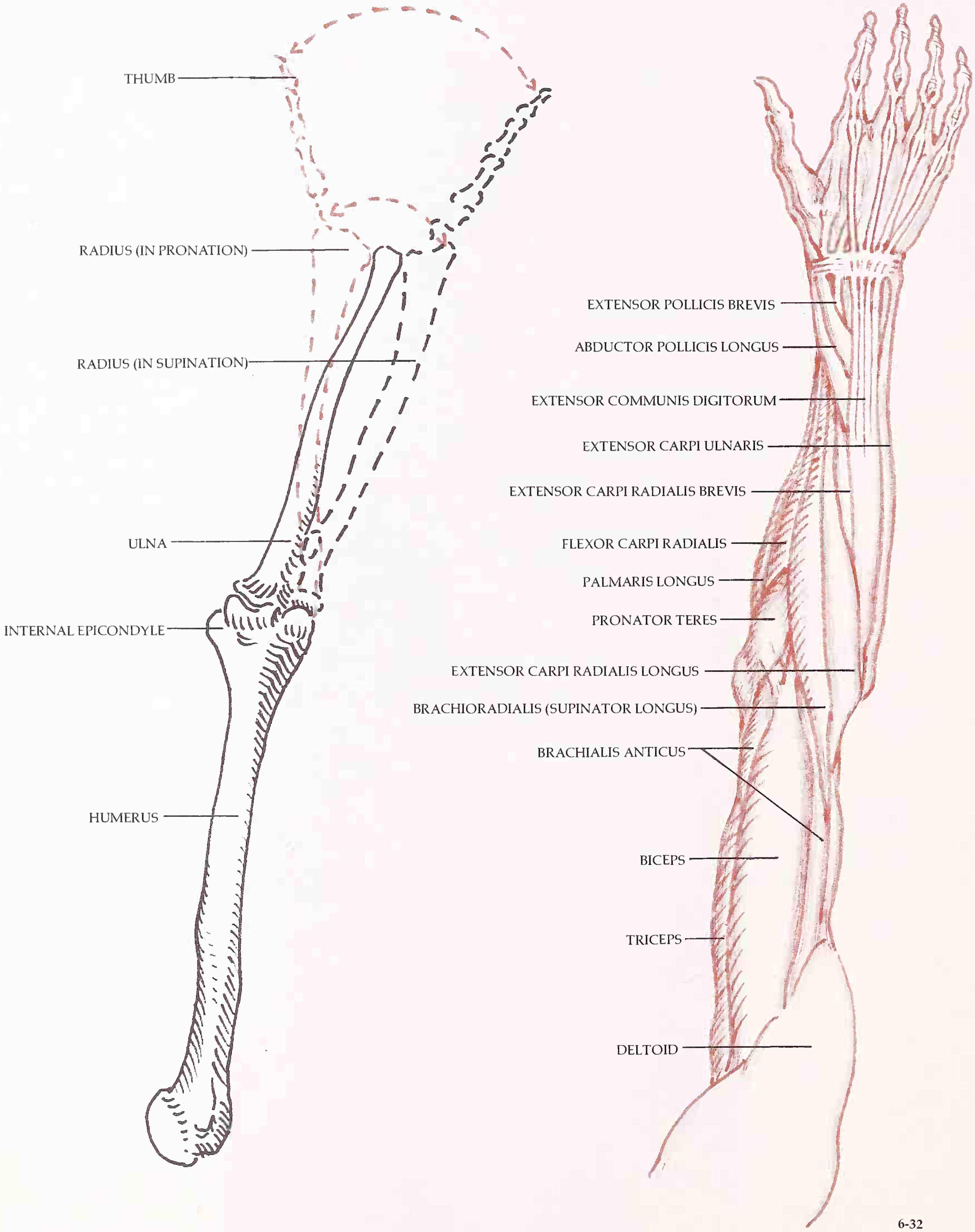
The radius bone, pivoting against the lower end of the humerus at the round radial head (capitellum), turns over the unmoving shaft of the ulna [6-32]. This is a combined action of a number of flexor and extensor muscles. With the elbow stationary, the hand may be turned palm down. The radius is the active bone. In this act of rotation, the forearm muscles make an elongated spiral twist diagonally around the ulna bone [6-32]. It is this action that can cause great confusion, and the forearm should be carefully studied and drawn in the supine position (palm up) and the prone position (palm down) [6-34, 6-35].

6-31
Detail of Muscles of the Inner Arm, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus.(Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Jonathan Goell.)

The flexor muscles of the forearm in supination are shown.

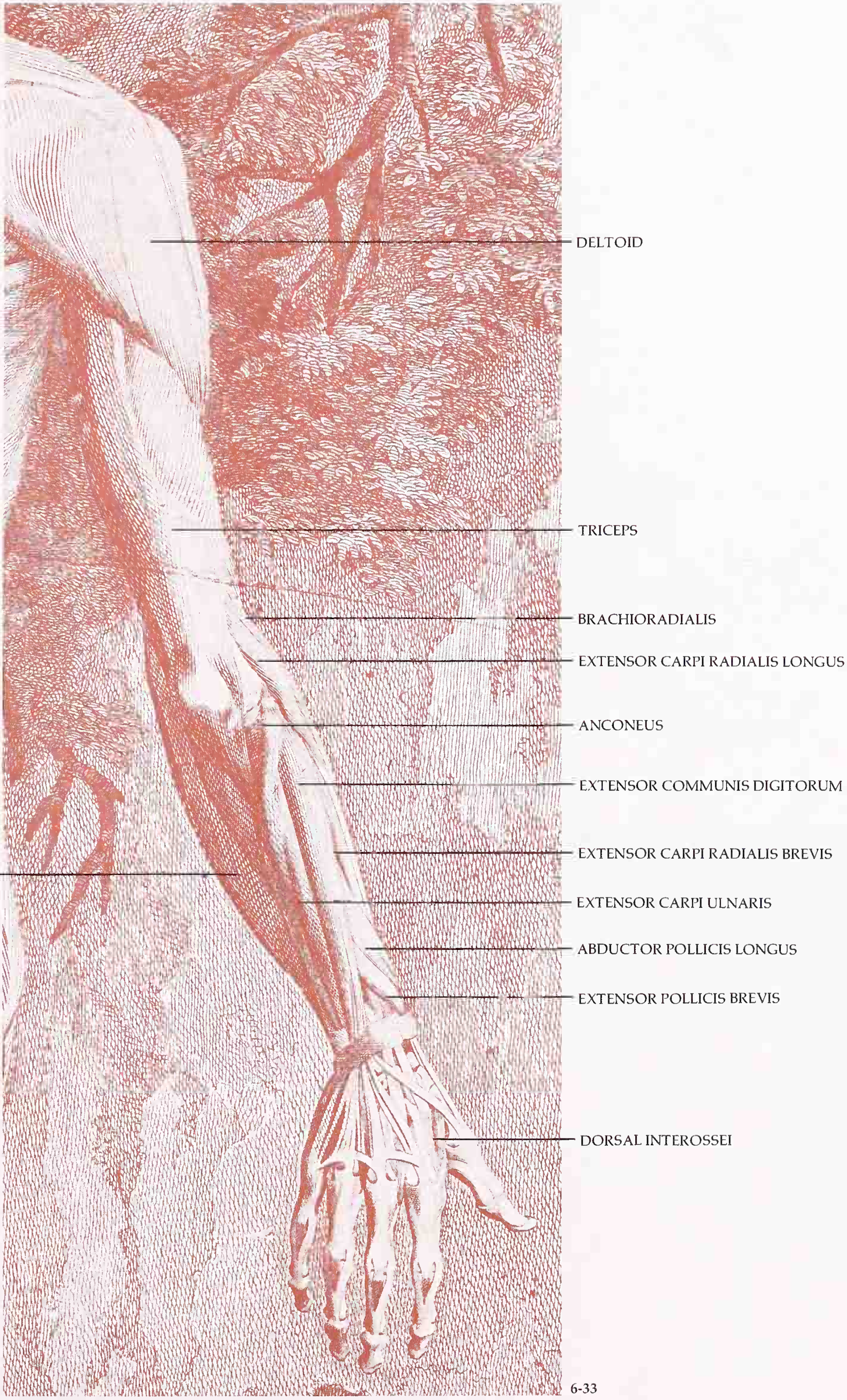

FLEXOR BREVIS MINIMI DIGITI
PALMARIS BREVIS
ABDUCTOR MINIMI DIGITI
FLEXOR CARPI ULNARIS
FLEXOR DIGITORUM SUBLIMUS
FLEXOR CARPI RADIALIS
PALMARIS LONGUS
BRACHIORADIALIS
PRONATOR TERES
BRACHIALIS ANTICUS
BICEPS
TRICEPS
DELTOID
FLEXOR POLLICIS BREVIS
ABDUCTOR POLLICIS
OPPONENS POLLICIS

6-31


THUMB
RADIUS (IN PRONATION)
RADIUS (IN SUPINATION)
ULNA
INTERNAL EPICONDYLE
HUMERUS
EXTENSOR POLLICIS BREVIS
ABDUCTOR POLLICIS LONGUS
EXTENSOR COMMUNIS DIGITORUM
EXTENSOR CARPI ULNARIS
EXTENSOR CARPI RADIALIS BREVIS
FLEXOR CARPI RADIALIS
PALMARIS LONGUS
PRONATOR TERES
EXTENSOR CARPI RADIALIS LONGUS
BRACHIORADIALIS (SUPINATOR LONGUS)
BRACHIALIS ANTICUS
BICEPS
TRICEPS
DELTOID

6-32

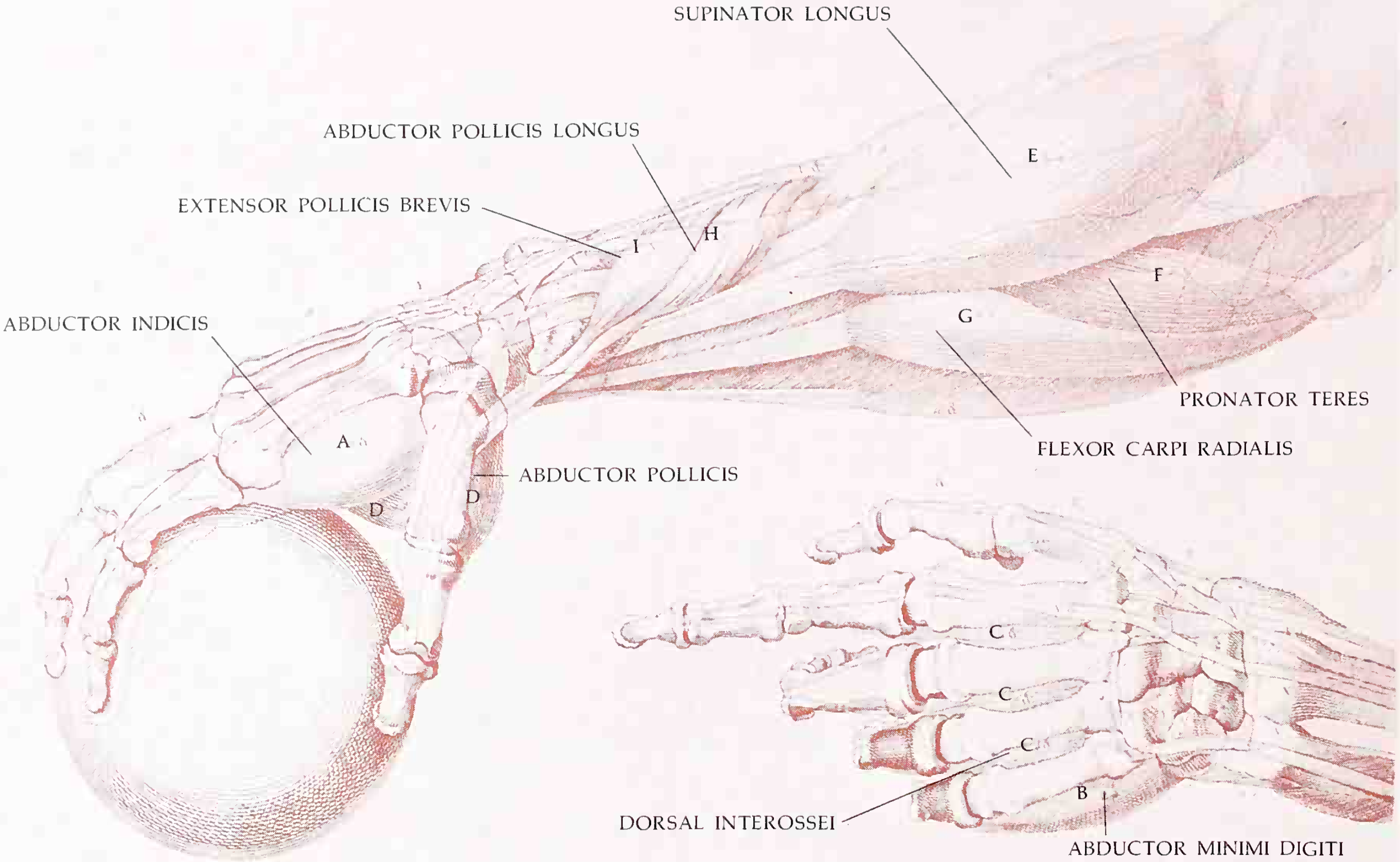
6-32
Bones and Muscles of the Arm.
The diagram on the left shows the position of the radius in pronation and supination. On the right, the muscles of the forearm are shown in pronation.


DELTOID
TRICEPS
BRACHIORADIALIS
EXTENSOR CARPI RADIALIS LONGUS
ANCONEUS
EXTENSOR COMMUNIS DIGITORUM
FLEXOR CARPI ULNARIS
EXTENSOR CARPI RADIALIS BREVIS
EXTENSOR CARPI ULNARIS
ABDUCTOR POLLICIS LONGUS
EXTENSOR POLLICIS BREVIS
DORSAL INTEROSSEI

6-33

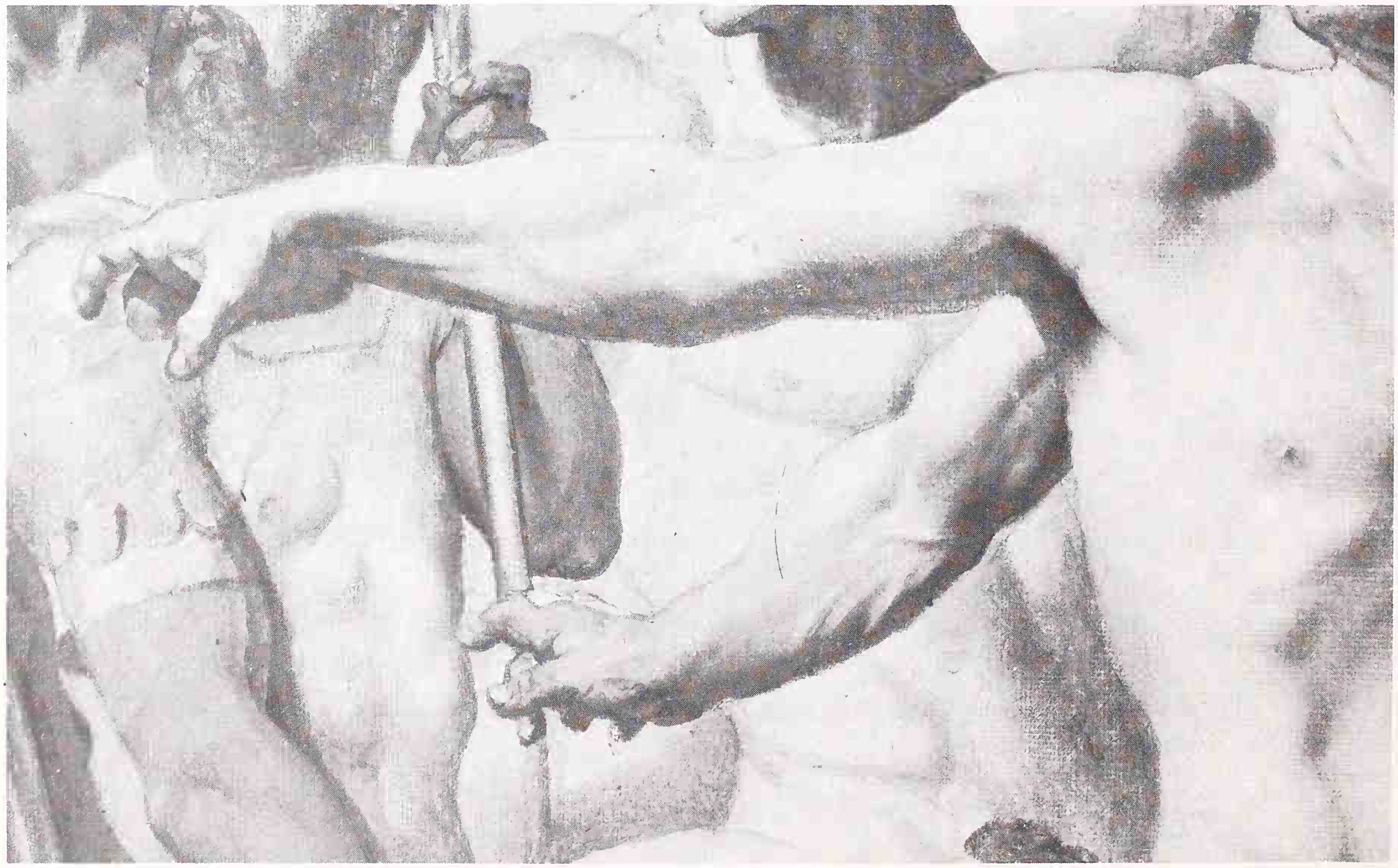
6-33

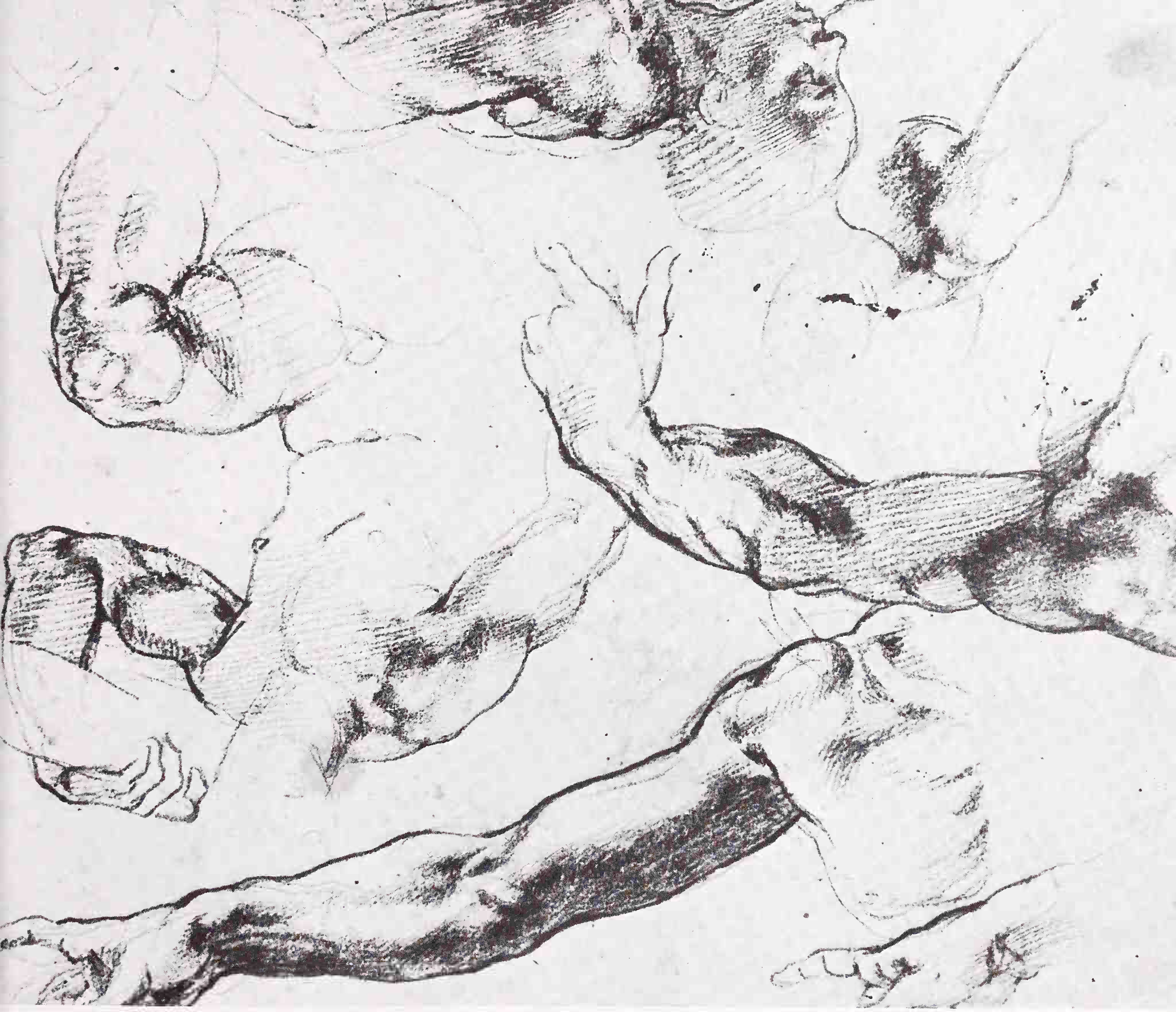
Detail of Muscles of the Arm, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Jonathan Goell.)


SUPINATOR LONGUS
ABDUCTOR POLLICIS LONGUS
E
EXTENSOR POLLICIS BREVIS
I
H
F
ABDUCTOR INDICIS
G
PRONATOR TERES
A
FLEXOR CARPI RADIALIS
D
D
ABDUCTOR POLLICIS
C
C
C
B
DORSAL INTEROSSEI
ABDUCTOR MINIMI DIGITI

6-34

6-35





6-36

6-34

Muscles of the Inner Forearm and Hand, from Anatomy of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

Seen in the illustration, the muscles of the hand are: abductor indicis (first dorsal interossei) *(A)*; abductor minimi digiti *(B)*; dorsal interossei *(C)*; abductor pollicis *(D)*. The muscles of the forearm in pronation (palm down) are: supinator longus (brachioradialis) *(E)*; pronator teres *(F)*; flexor carpi radialis *(G)*; abductor pollicis longus *(H)*; extensor pollicis brevis *(I)*.

6-35

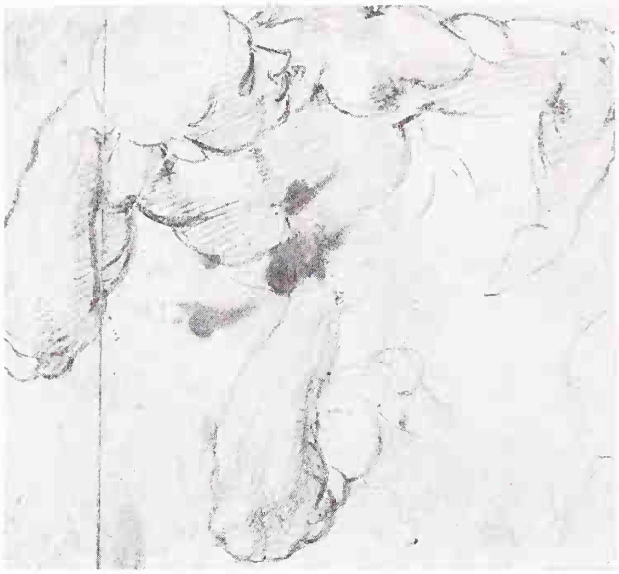
Detail of Two Arms from Studies for the Martyrdom of St. Symphorien by Jean Dominique Ingres. (Courtesy: Fogg Art Museum, Harvard University; Grenville L. Winthrop Bequest.)

The continuity of interconnected forms is well understood by Ingres.

6-36

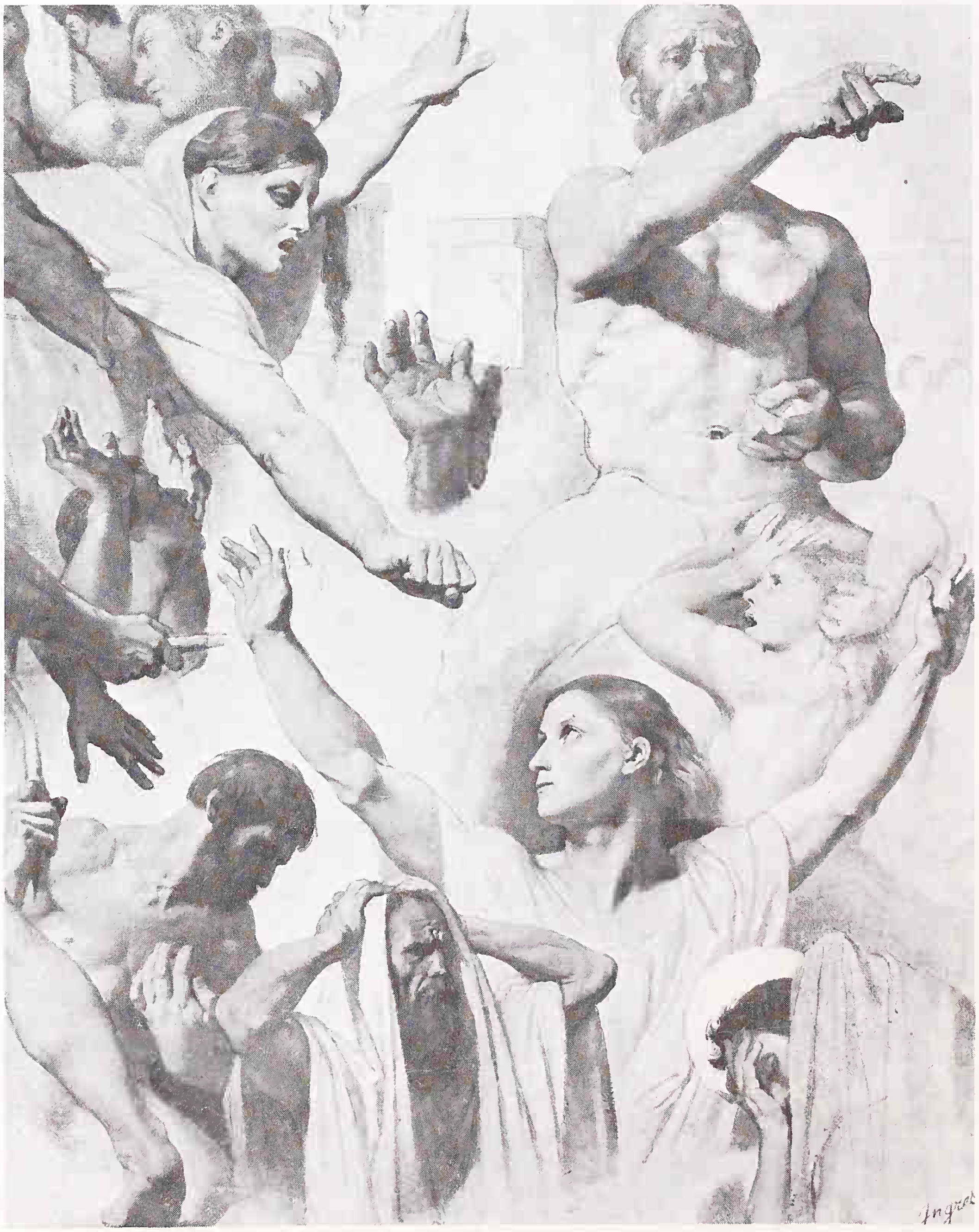
Studies of the Arm by Michelangelo. (Teylers Stichting, Haarlem.)

The muscles as drawn by Michelangelo in these studies may be compared with those in the anatomical illustration by Salvage [6-34].



6-37

6-38



6-37
Detail from Studies of the Arm by Michelangelo. (Teylers Stichting, Haarlem.)

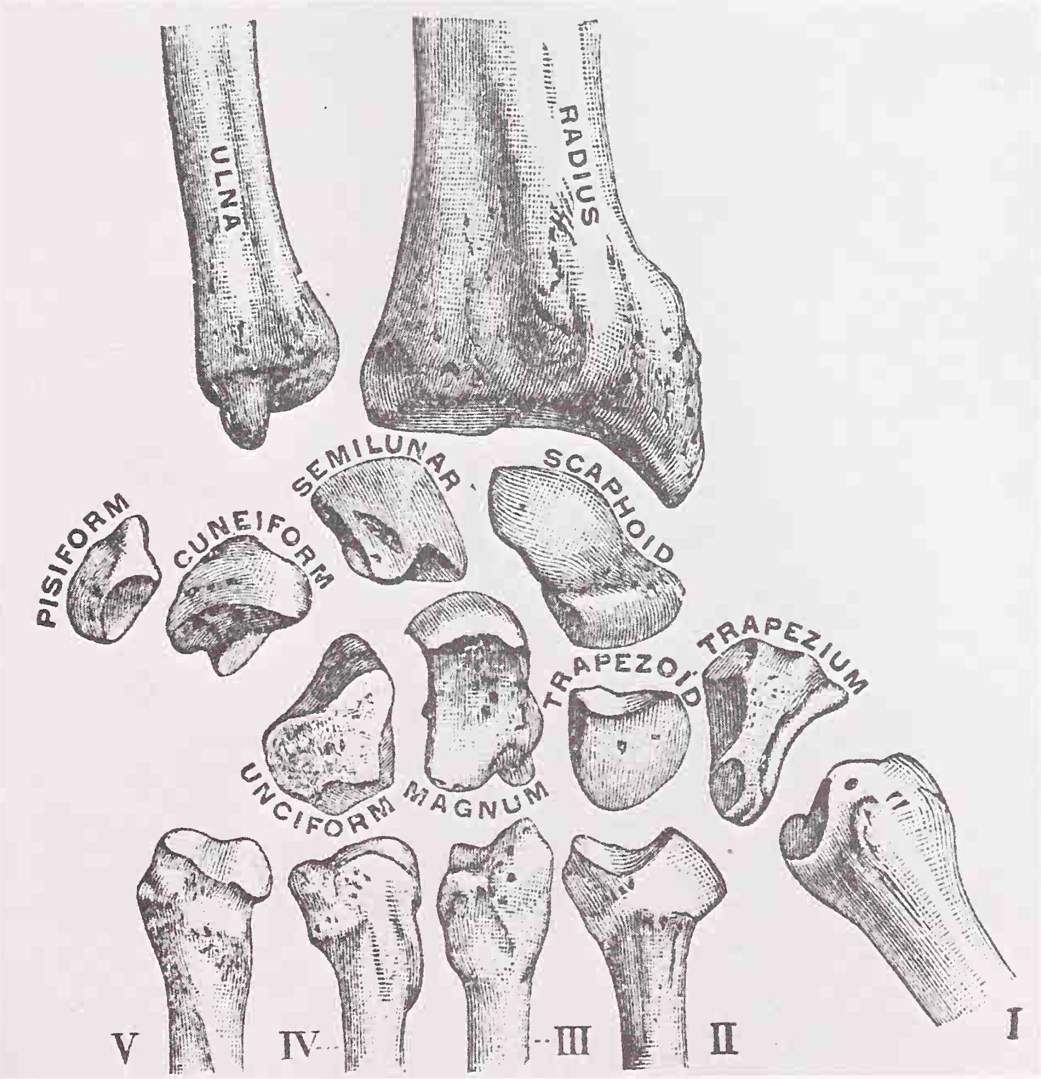
6-38
Study for the Martyrdom of St. Symphorien by Jean Dominique Ingres. (Fogg Art Museum, Harvard University; Grenville L. Winthrop Bequest.)

The arms and hands have been carefully observed in a number of views.

THE WRIST

The wrist, the link between the forearm and the hand, is frequently bypassed as a distinct unit of form. If it is not carefully taken into account in drawing, the result is a stiff or broken appearance between the hand and the forearm. When the carpal structure (the eight bones of the wrist) is recognized as an entity and an important transitional connection, this articulation will contribute to a fluid and organically convincing sequence of forms [6-39 to 6-42].

The carpal (wrist) ends of the ulna and radius are prominent and offer identifiable clues to the movement into the wrist articulation. Ample length should be given the wrist area to fully account for the wrist, plus the hand. Careful study of illustrations 6-39 to 6-42 is recommended, as they present this articulation clearly.

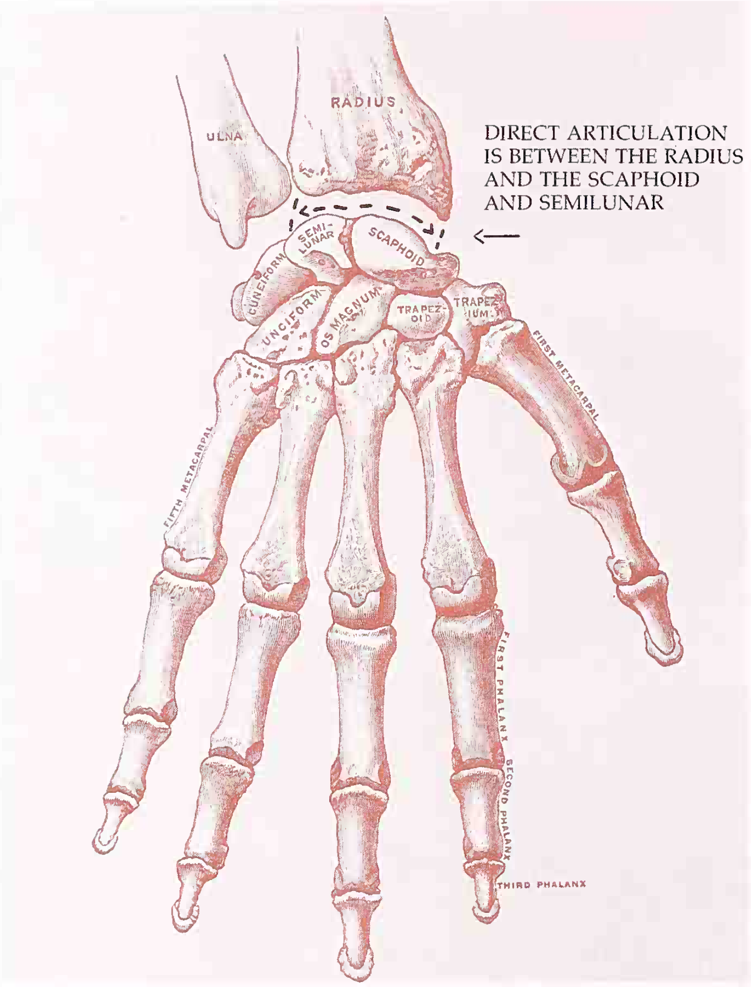


6-39

6-39

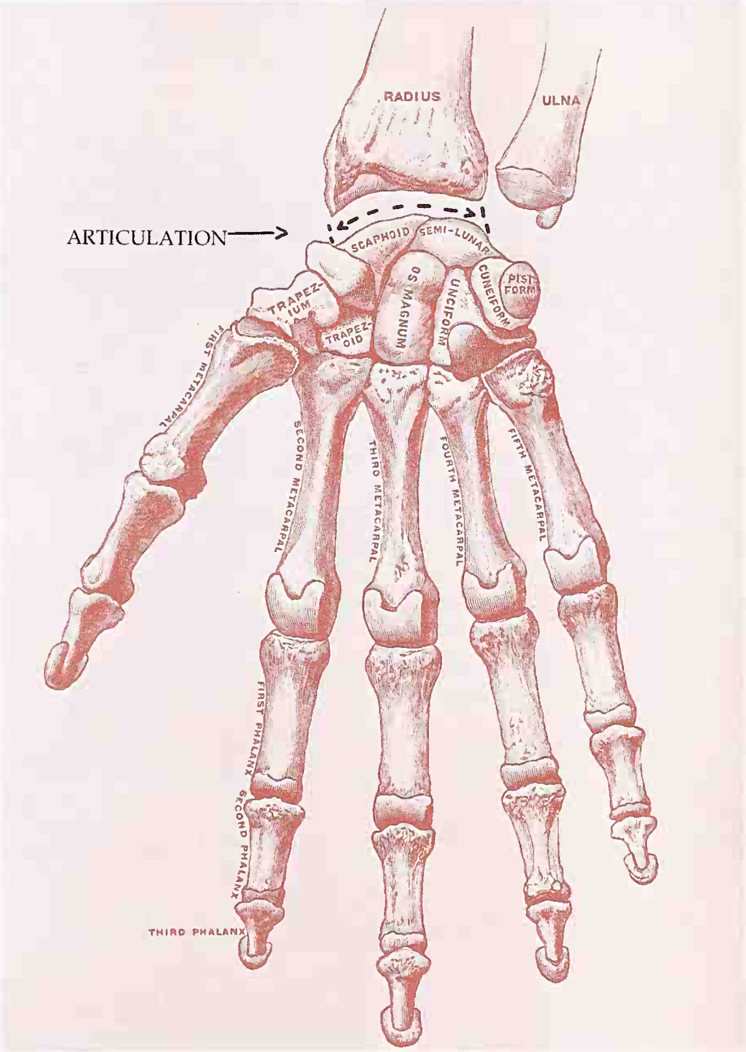
The Carpus (Wrist Bones), from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The eight small bones of the wrist are known as the carpus. This articulation has remarkably extensive and subtle movement, the result of numerous small gliding actions between many bones.


RADIUS
ULNA
SEMI-LUNAR
SCAPHOID
CUNEIFORM
UNCIFORM
OS MAGNUM
TRAPEZOID
TRAPEZIUM
FIRST METACARPAL
FIFTH METACARPAL
FIRST PHALANX
SECOND PHALANX
THIRD PHALANX

DIRECT ARTICULATION IS BETWEEN THE RADIUS AND THE SCAPHOID AND SEMILUNAR

6-40


RADIUS
ULNA
SCAPHOID
SEMI-LUNAR
TRAPEZIUM
TRAPEZOID
OS MAGNUM
UNCIFORM
CUNEIFORM
PISIFORM
FIRST METACARPAL
SECOND METACARPAL
THIRD METACARPAL
FOURTH METACARPAL
FIFTH METACARPAL
FIRST PHALANX
SECOND PHALANX
THIRD PHALANX

ARTICULATION

6-41

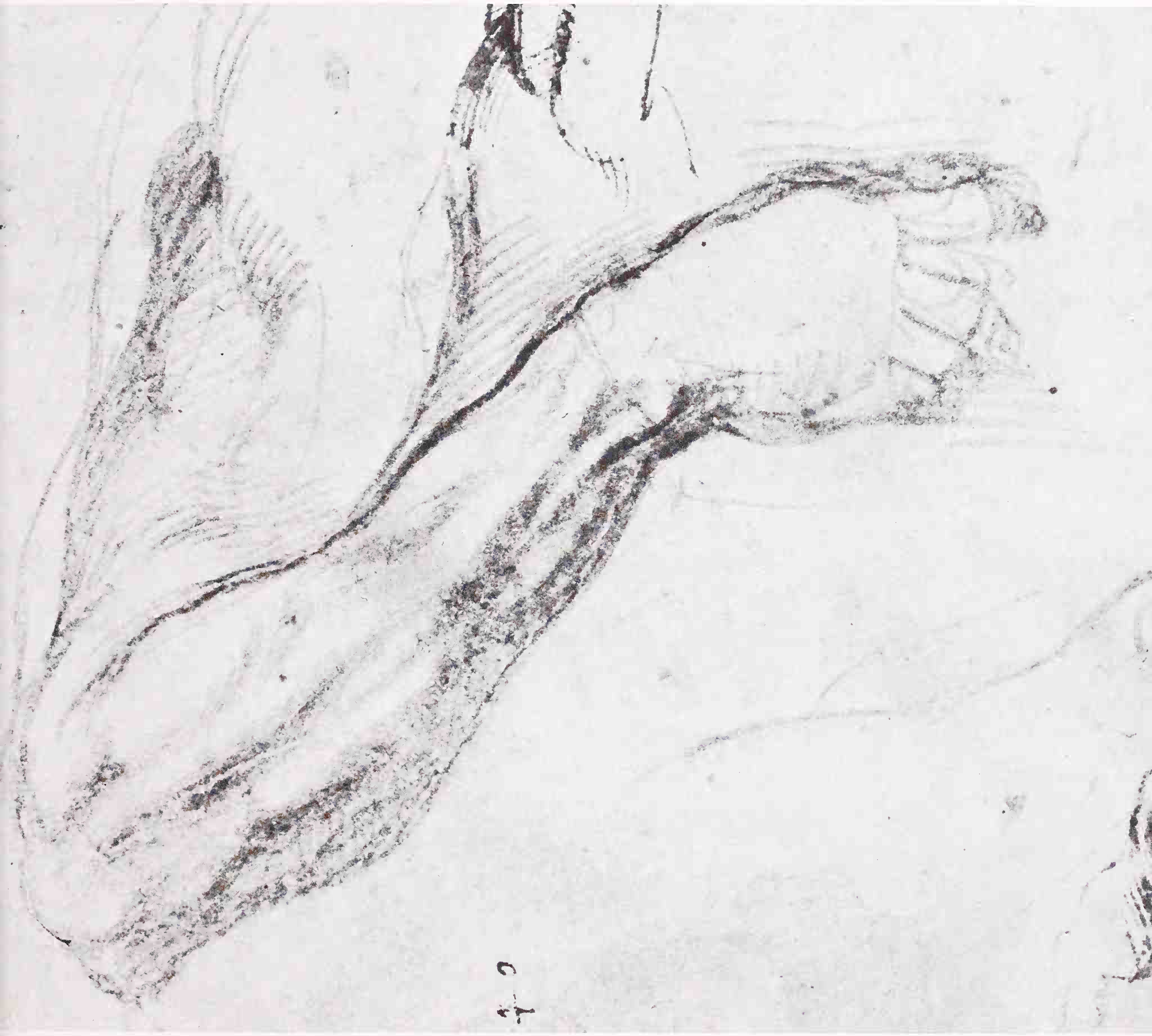
6-40

The Bones of the Right Hand: Dorsal View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

6-41

Bones of the Hand: Palmar View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The articulation between forearm and wrist involves three bones: the radius of the forearm, and the scaphoid and semilunar of the carpus (wrist).



6-42

6-42

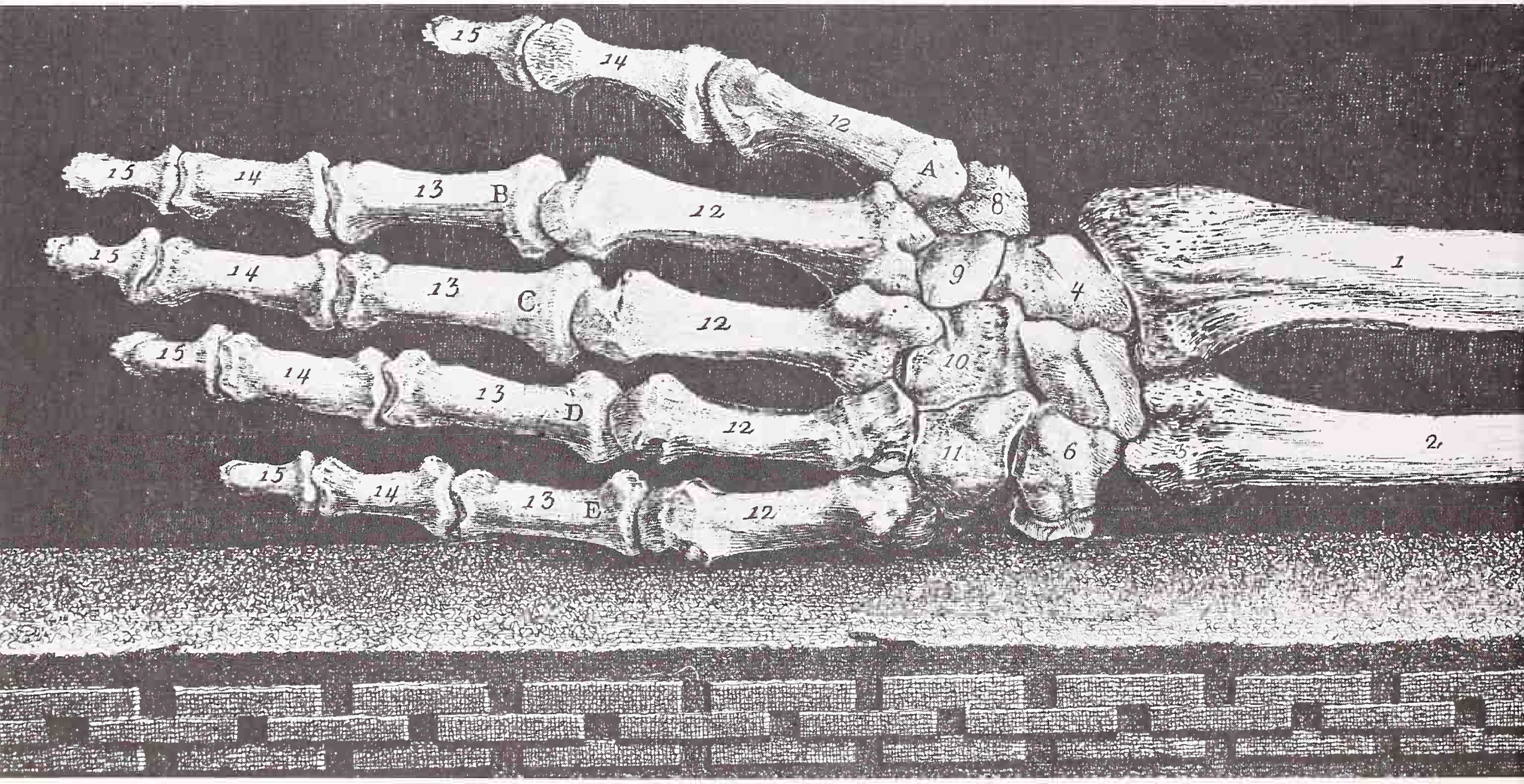
Forearm Detail from Studies of the Arm by Michelangelo. (Teylers Stichting, Haarlem.)

A superbly articulated, fluent drawing of the joined units of the hand, wrist, and forearm. Note especially the length and blocklike form of the wrist.

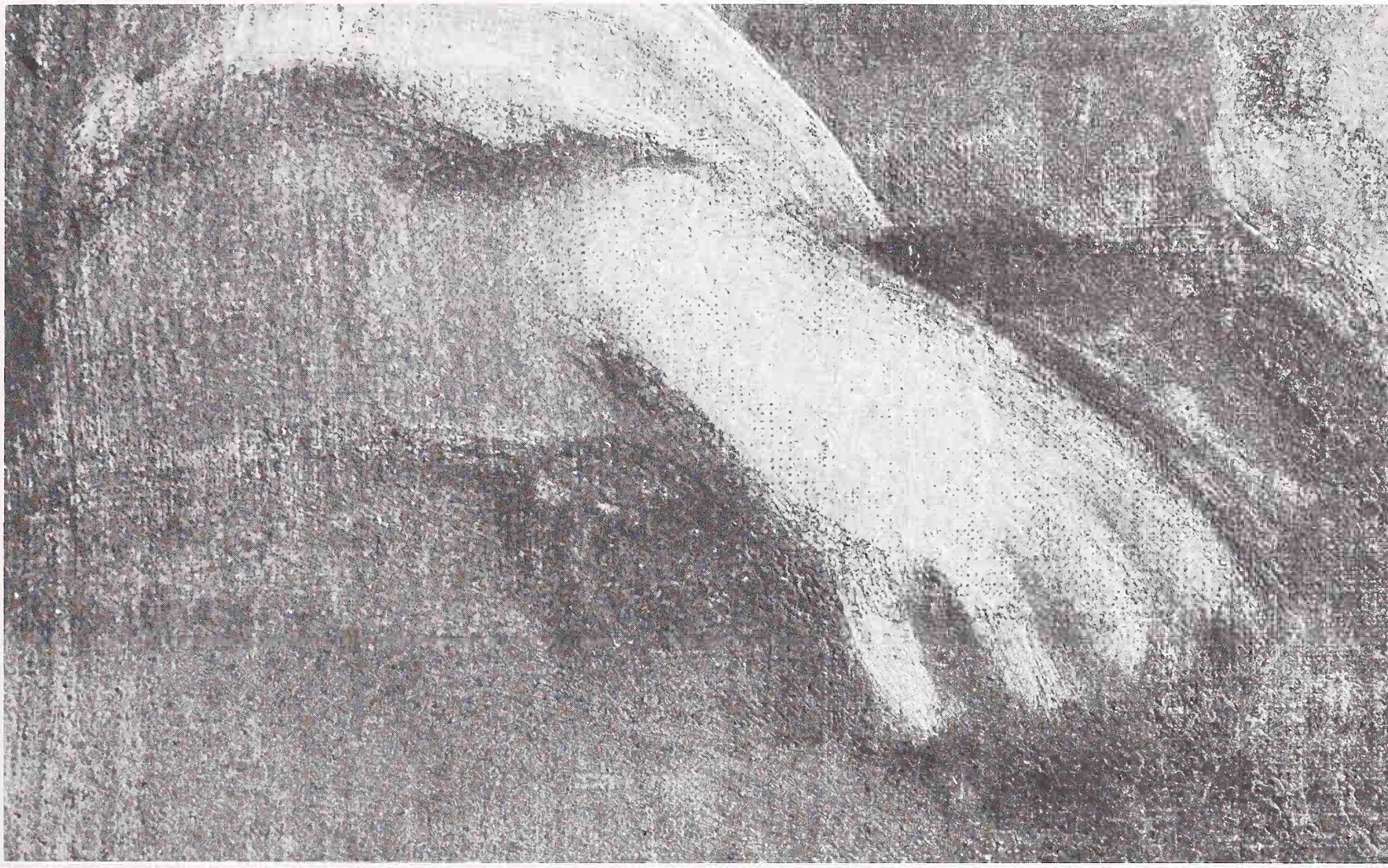
THE HAND

One obvious structural difference between the palm and the back of the hand should be immediately apparent. The palm is fleshy and muscular; the back of the hand is bony and tendinous. The five metacarpal bones make up the body of this form from the wrist to the knuckle. On the back of the hand, each metacarpal can be felt, and when the fingers are tightened into a fist, the phalangeal ends (knuckles) are thrust into prominence. The unique articulation of the metacarpal of the thumb permits it to bend in opposition to the fingers (as in grasping). The plane formed by the metacarpals of the thumb and index finger (roughly triangular) rests at right angles to the back of the hand but may be flattened to align with it (see illustrations 6-39 to 6-51).

Contributing to the prominence of the knuckles are the tendons of the extensor communis digitorum muscle stretched over the end of the form [6-25]. The deeper muscles between the metacarpal bones fill out the body of the hand and act on the fingers, drawing them together when extended or separating them in fan-shape. These are the interossei dorsales and the interossei palmares. When the fingers are extended, they may appear shorter on the palmar side. This is caused by the fleshy "webbing" between the fingers which extends forward between the knuckles.



6-43



6-44

6-43

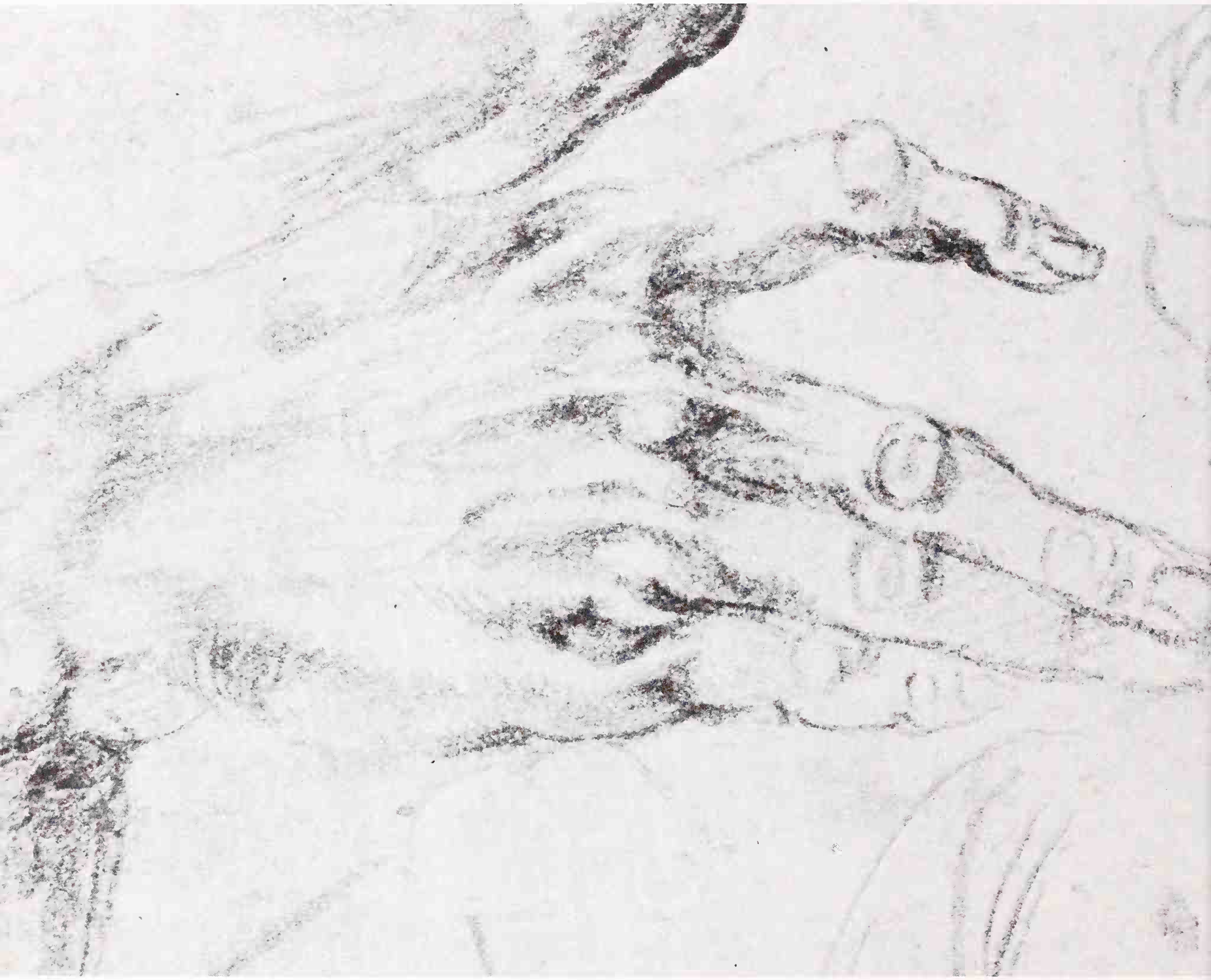
Bones of the Hand, Dorsal View, from Twenty Plates of the Osteology and Myology of the Hand, Foot, and Head by Antonio Cattani. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Jonathan Goell.)

In the view of the back of the hand, the forearm bones, the radius *(1)* and the ulna *(2)*, join with the eight carpal bones of the wrist. The bones of the carpus are as follows: scaphoid *(4)*; lunate *(5)*; cuneiform *(6)*; pisiform *(7)*; trapezium *(8)*; trapezoid *(9)*; os magnum *(10)*; unciform *(11)*. The body of the hand, from the wrist to the knuckles, is made up of the metacarpals *(12)*. The phalanges *(13, 14,* and *15)* are the bones of the thumb and fingers. In drawing the hand, sufficient space between the forearm (radius and ulna) and the back of the hand (metacarpals) should be allowed for the eight bones of the wrist (carpus.)

6-44

Detail from Allegory of Fidelity by Tintoretto. (Fogg Art Museum, Harvard University, Gift of Mrs. Samuel Sachs in memory of Mr. Samuel Sachs.)

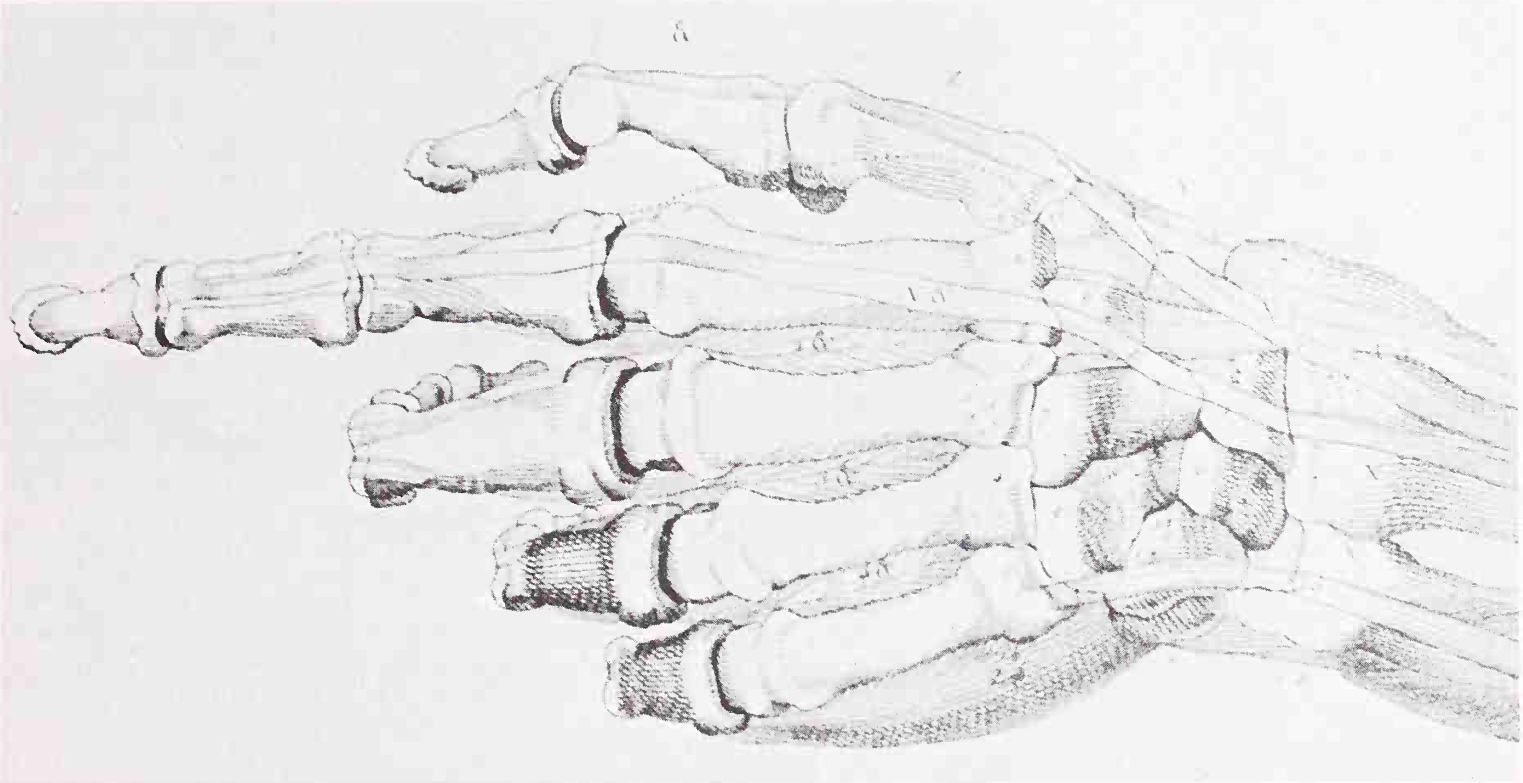
The broad impasto brushwork (apparently easy and spontaneous) is precise in length and dimension to accommodate the wrist and the back of the hand. The curvature through the knucles and the thinning of the brushstroke above the index finger turn the form. (The painting is reproduced in full in illustration 1-8.)



6-45

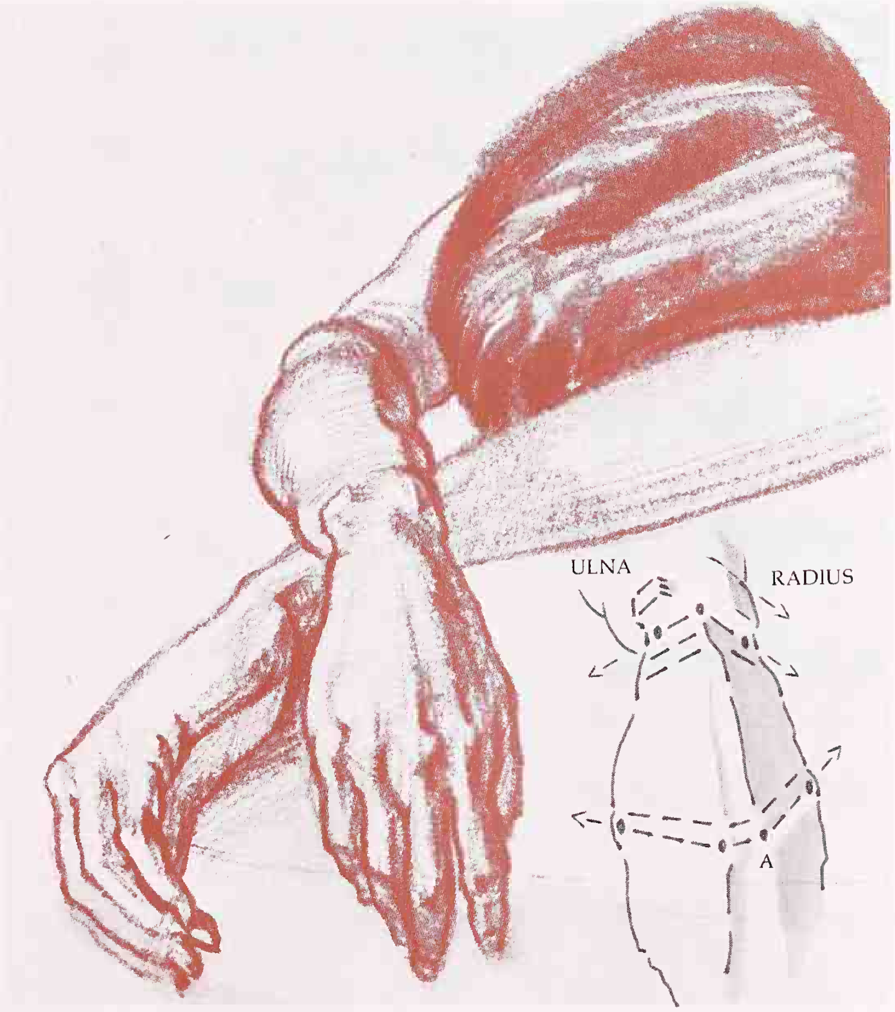
6-45
Detail of a Hand from Studies of the Arm by Michelangelo. (Teylers Stichting, Haarlem.)

Muscle tendons are visible extending over the knuckles into the fingers. The blocklike structure of the fingers (in this illustration, the index finger) should not be confused by wrinkles at the articulation of the digits.



6-46

6-47



6-46

The Hand, from Anatomy of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.

The tendons extending from the muscles in the forearm articulate the fingers and are visible as ridgelike strands in the tensed hand. The obvious complication of the hand by tendons and veins requires care and selectivity on the part of the artist to retain the unity of underlying broad surfaces. (Compare this with the drawing by Michelangelo [6-45].)

6-47

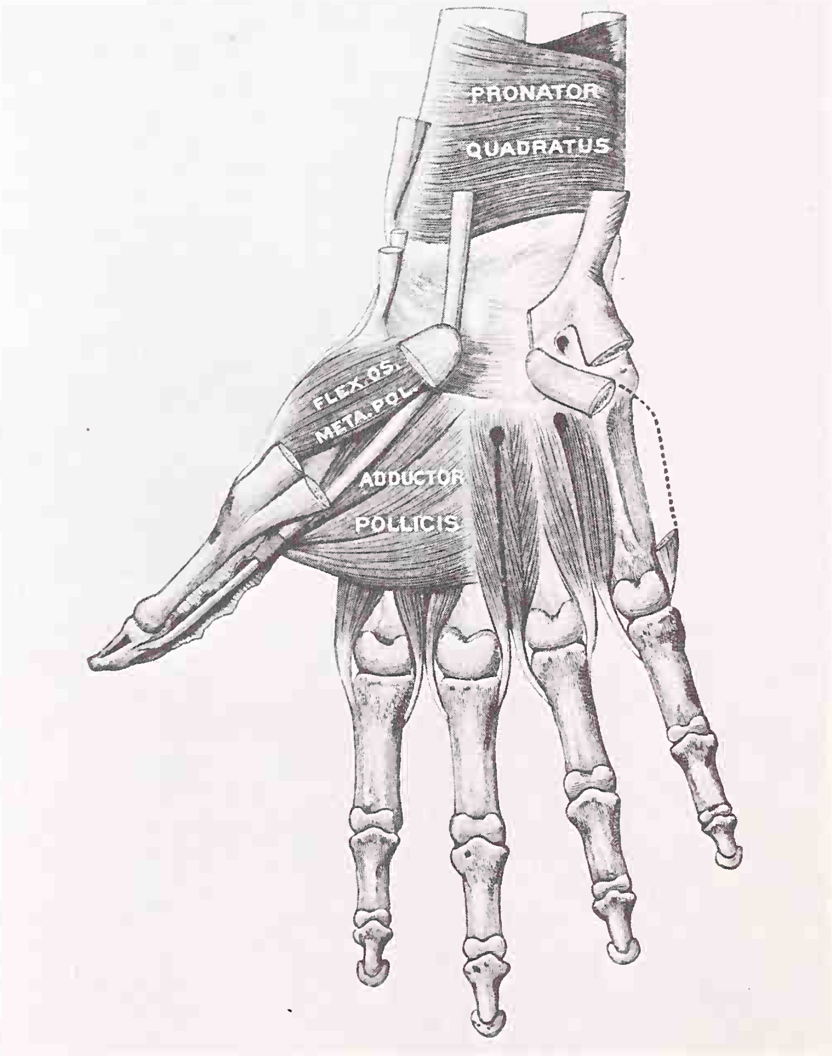
Detail from Study and Analysis of Planes of the Hand by the author. (Photograph by Kalman Zabarsky.)

In the relaxed, unsupported hand, the metacarpal bone of the thumb rests almost at right angles to the four metacarpals of the fingers. This division of planes occurs along the axis of the index finger *(A)*. As a plane it can continue into the wrist and forearm.

The palm of the hand is padded by an arrangement of muscles that frame a basinlike depression at its center. Short, thick muscles filling out the heel of the hand from the wrist to thumb create an egglike fullness. Unified in appearance, the muscles that build up this form are the opponens pollicis, the flexor pollicis brevis, and the abductor pollicis brevis [6-48, 6-50].

The muscles framing the side of the palm over the metacarpal of the little finger are thinner and about the length of this bone. They are the opponens digiti quinti, the flexor digiti quinti brevis, and the abductor digiti quinti and the palmaris brevis (see figures 6-27, 6-49).

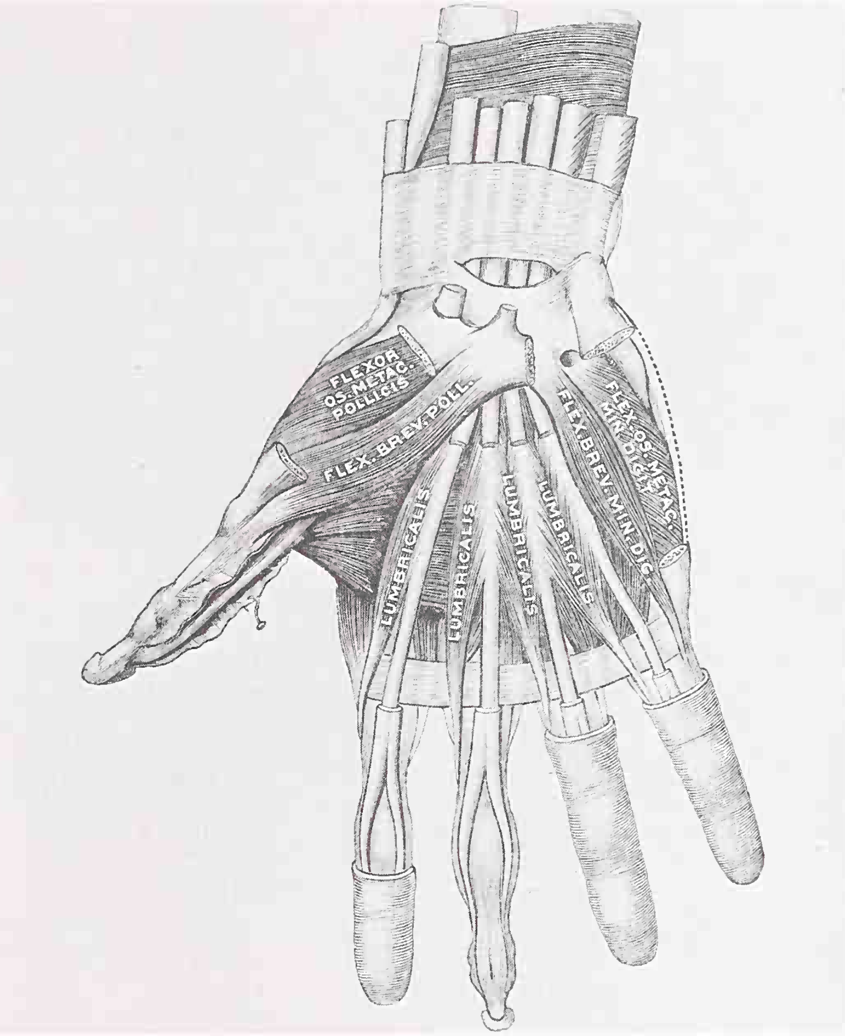
The digits (phalanges), though small, have a thin shaft and enlarged extremities. The expanded forms of the articular heads create the structure for the four long planes enclosing the fingers (see figure 6-41). When the fingers are extended, wrinkles gather at the articulation of each digit. This is a distraction that should not obscure the longer top and side planes which run the full length from knuckle to fingertip.



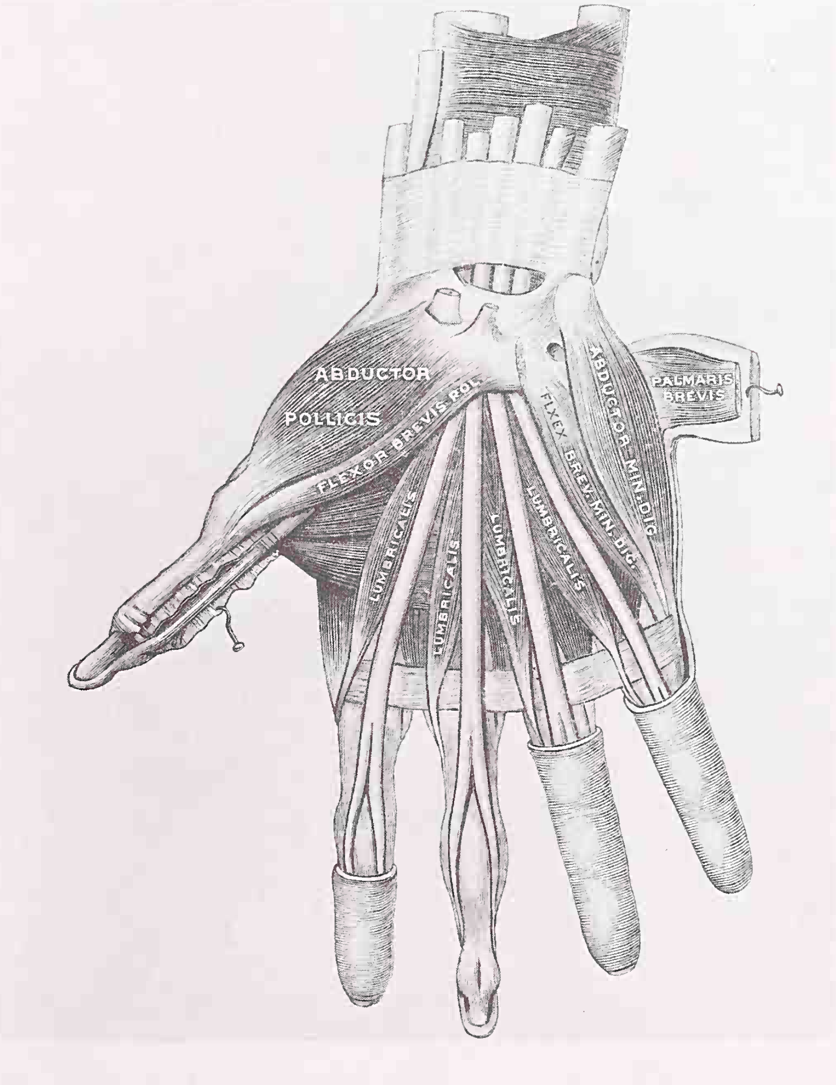
6-48

6-48
Deep Muscles of the Hand, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The adductor pollicis, flexor ossis metacarpi pollicis, and pronator quadratus are shown here.


FLEXOR OS. METAC. POLLICIS
FLEX. BREV. POLL.
LUMBRICALIS
LUMBRICALIS
LUMBRICALIS
LUMBRICALIS
FLEX. BREV. MIN. DIG.
FLEX. OS. METAC. MIN. DIGIT.

6-49


ABDUCTOR
POLLICIS
FLEXOR BREVIS POL.
LUMBRICALIS
LUMBRICALIS
LUMBRICALIS
LUMBRICALIS
FLEX. BREV. MIN. DIG.
ABDUCTOR MIN. DIG.
PALMARIS BREVIS

6-50

6-49

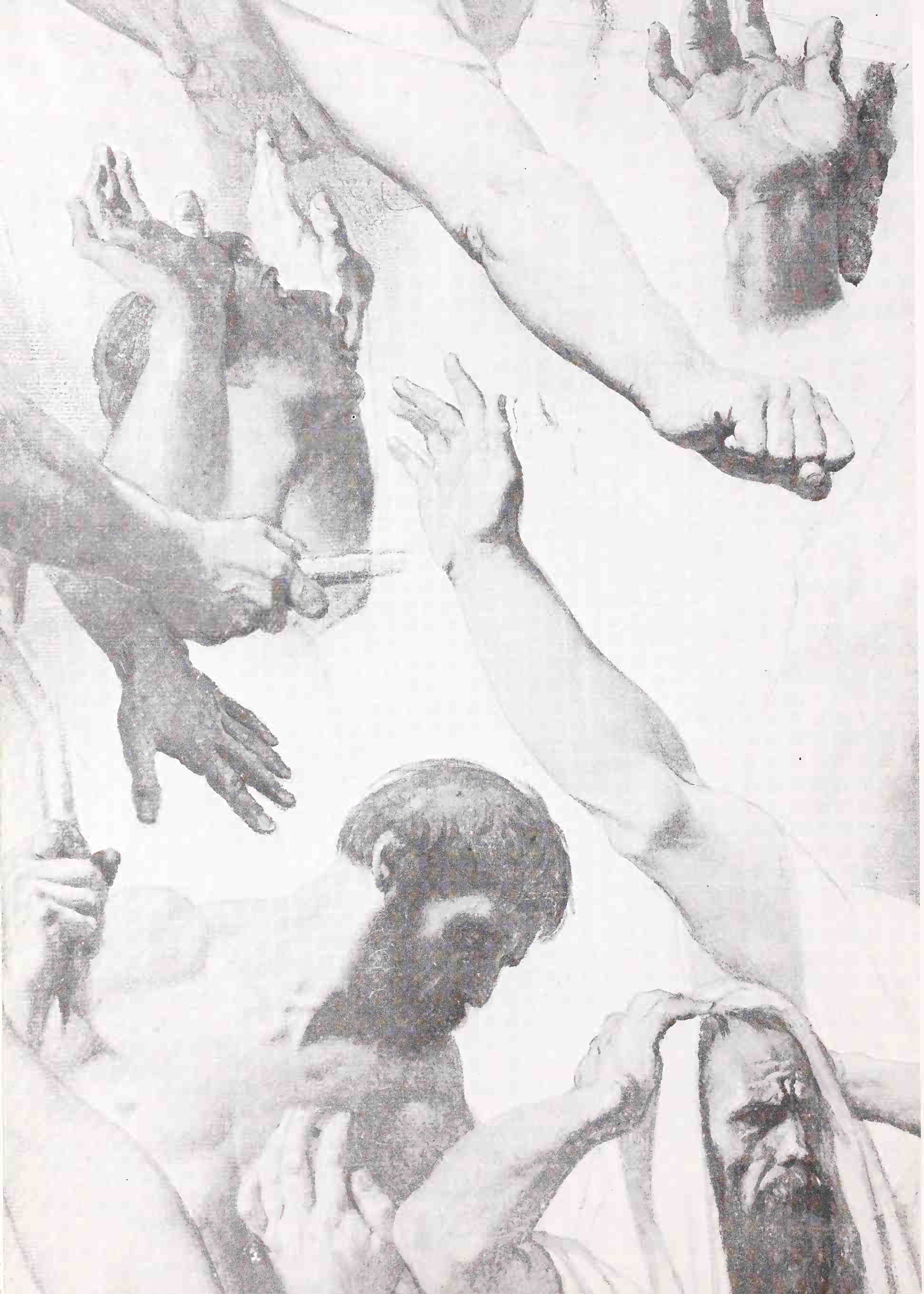
Deep Muscles of the Hand, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

In this illustration the abductors of the thumb and the little finger have been removed.

6-50

Superficial Muscles of the Right Palm, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

Illustrated are the abductor pollicis, palmaris brevis (peeled back), abductor minimi digiti, flexor brevis minimi digiti, and the lumbricalis.



6-51

Study Assignment

Upper Extremity

Draw humerus

1. study ball and socket joint with scapula.
2. study hinge joint at elbow: study trochlea and capitellum.

Muscles: draw extensors and flexors of upper arm.

Radius and ulna: draw radius and ulna in pronation. Draw radius and ulna in supination.

Muscles: draw extensors, flexors, supinator, and pronator of arm and hand.

Hand: draw your hand reflected in a mirror, at least five views:

1. open: palm up
2. fist: palmar view
3. open: dorsal (back view)
4. thumb side
5. hand—partial flexion of fingers

Alternate Exercise

Indicate on tracing vellum placed over a drawing of the bones of the arm and hand, the muscles of the arm and hand. Show origin and insertion of each muscle.

6-51
Detail from Study of the Martyrdom of St. Symphorien by Jean Dominique Ingres. (Fogg Art Museum, Harvard University; Grenville L. Winthrop Bequest.)

The palm of the hand is thickly padded with short muscles. This is in sharp contrast to the back of the hand, which is bony and tendinous.

THE LOWER EXTREMITY

Bones of the Thigh, Leg, and Foot

THIGH
femur
  head, neck, great trochanter,
  internal condyle, external condyle
KNEE AND LOWER LEG
patella
tibia
  internal condyle tuberosity,
  external condyle tuberosity,
  inner malleolus
fibula
  outer malleolus
FOOT
tarsus (7 bones)
  talus (astragalus),
  os calcis (calcaneum),
  cuboid, scaphoid,
  internal cuneiform,
  middle cuneiform,
  external cuneiform
metatarsals
phalanges

Muscles of the Thigh, Leg, and Foot

THIGH
ilio-psoas
tensor fasciae latae
adductor magnus
adductor brevis
adductor longus
pectinius
gracilis
sartorius
quadriceps femoris: rectus femoris,
  vastus externus,
  vastus internus, crureus
ilio-tibial band
biceps femoris
semitendinosus
semimembranosus
LOWER LEG
gastrocnemius
Achilles' tendon
soleus
flexor digitorum longus
flexor hallucis longus
tibialis anterior
peroneus longus
peroneus brevis
extensor digitorum longus (communis)
extensor hallucis longus
FOOT
extensor hallucis brevis
extensor digitorum brevis
abductor hallucis
abductor digiti quinti
flexor digitorum brevis

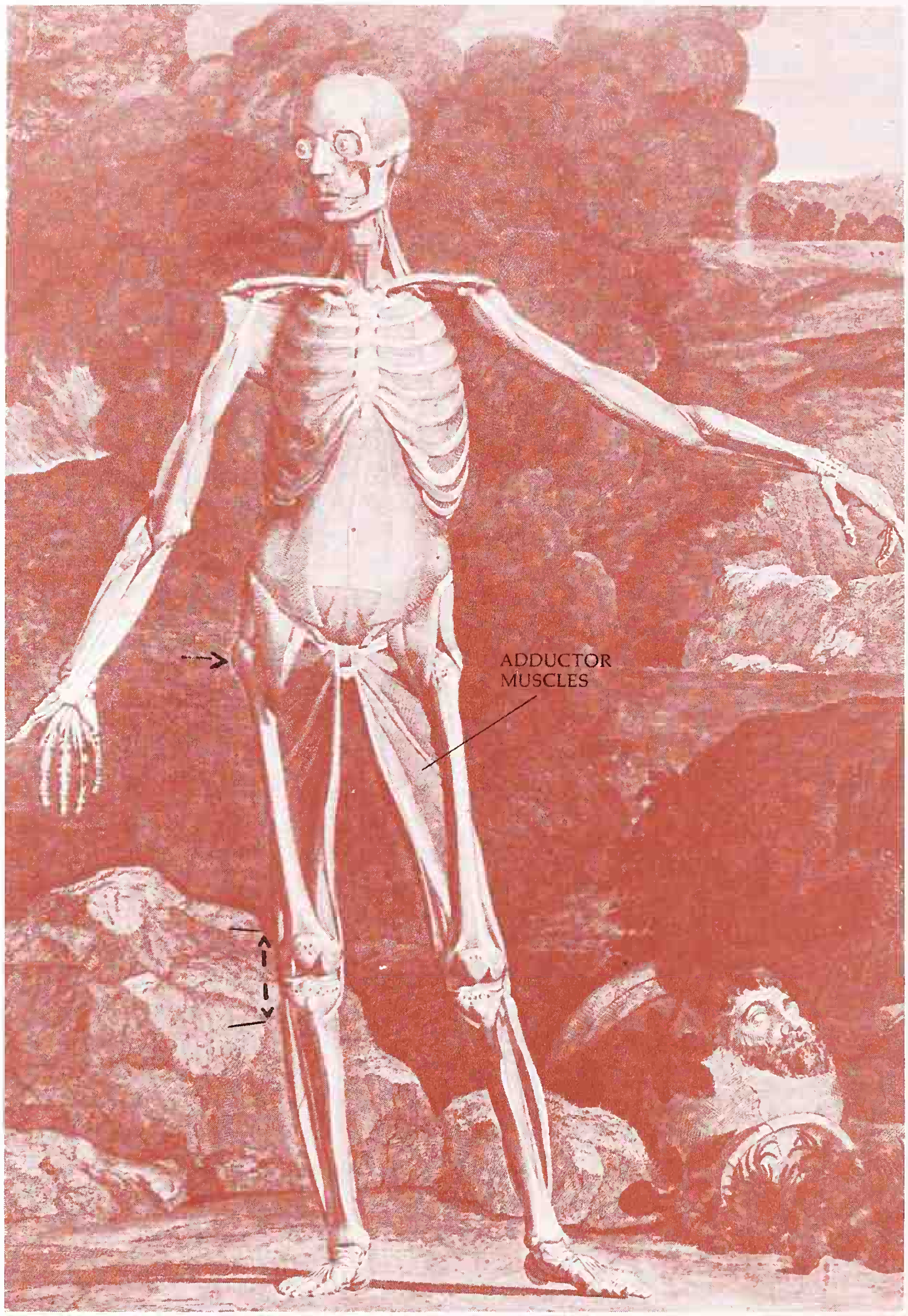
CHAPTER 7

THE LOWER EXTREMITY: THIGH, LEG, AND FOOT

The leg is composed of a strong and obvious interrelationship of muscles. The bones of the leg are long, with enlarged articulations (hip and knee) developed for the major functions of support, balance, and movement [7-1, 7-2, 7-3].

The longest bone, the femur, articulates with the outer framework of the pelvis known as the os innominatum by a ball-and-socket joint. The round head of the femur is joined to its lengthy shaft by a short diagonal neck of bone [7-3]. At this juncture, a blocklike tuberosity—the great trochanter—is influential on the form of the figure. When the weight of a figure is on one leg, this prominence on the supporting limb provides a clear angle of opposing directions between the thigh and the torso and is the peak for the regional planes of hip and upper thigh [7-1, 7-2, 7-3].

The blocklike volume at the lower end of the femur (thigh bone) is set on the equally wide head of the tibia below to form the knee and demonstrates the weight-bearing function of the leg [7-3]. It is a frequent occurrence that the only representation in drawing given to this large knee articulation is the patella (kneecap). Small, but obvious as a unit, the function of the patella is not support, but protection. Behind it is the substantial formation of two joined units—a structure that is repeatedly minimized or ignored as a lengthy extension of volume, clearly identified between the calf and the thigh. This large-scale bony framework is visible whether the leg is extended or bent [7-4, 7-30]. The reader may refer again to chapter 1, page 18, for an analysis of relationship. Also in chapter 1, observe in the works by Michelangelo [1-26] or Tintoretto [1-31, 1-33] the position of the kneecap to the underside of the leg. A sense of the full third dimension is projected by location alone (reinforced by modeling).



7-1

7-1

Detail of Skeleton with Deep Muscles: Front View, from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

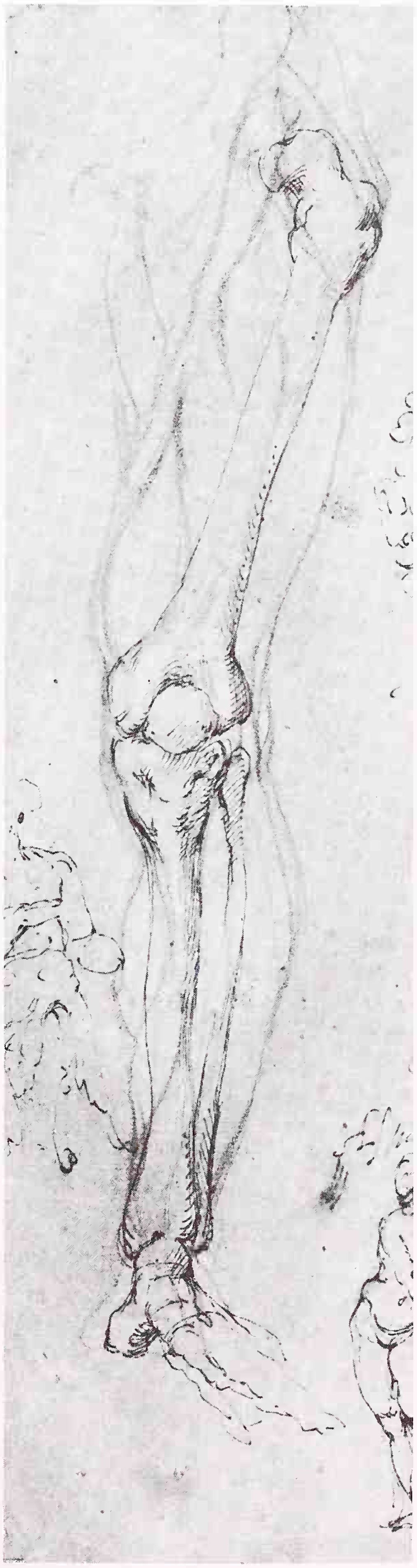
The influence of the great trochanter (arrow) of the femur bone, prominent at the hip in the weight-bearing leg, may be seen. two enlarged extremities of bone, the tuberosities of the femur and tibia, join to form, a long, blocklike unit at the knee. This is often ignored, minimized, or eliminated in drawing the leg, causing a stiff, incomplete, and unarticulated limb. Its dimension is enclosed between arrows at the knee. The relationship of deep muscles to bones is worth noting.

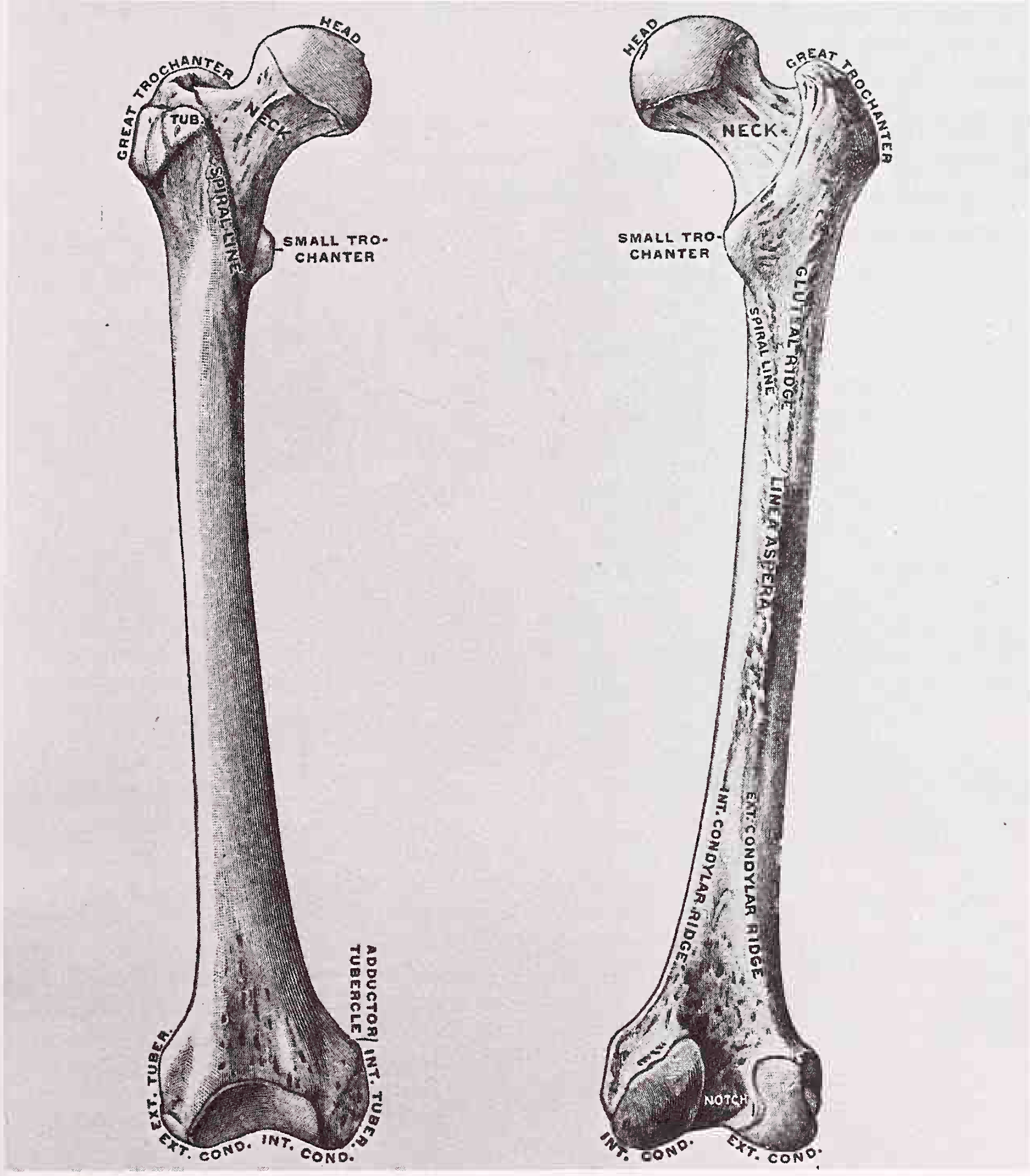
7-2

Bones of the Leg by Raphael da Montelupo. (Courtesy: Ashmolean Museum.)

This drawing indicates the influence of the bones of the leg on surface form at the hip (great trochanter), at the knee (encompassing the tuberosities of femur and tibia), and at the ankle. A comparison with the drawing by Tintoretto [7-12] reveals a close parallel of bone and muscle projection in this form.

7-2




HEAD
GREAT TROCHANTER
TUB.
NECK
SPIRAL LINE
SMALL TRO-CHANTER
ADDUCTOR TUBERCLE
INT. TUBER.
EXT. TUBER.
EXT. COND.
INT. COND.
HEAD
GREAT TROCHANTER
NECK
SMALL TRO-CHANTER
GLUTEAL RIDGE
SPIRAL LINE
LINEA ASPERA
EXT. CONDYLAR RIDGE
INT. CONDYLAR RIDGE
NOTCH
INT. COND.
EXT. COND.

7-3

7-3

The Femur Bone, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The illustration shows the right femur from the front (left) and from the rear (right).

THE THIGH

The muscles of the thigh fill out its volume in a dimensionally significant manner above the knee and into the hip. On all sides, the shaft of the femur is enclosed. This bone is only visible and directly influential on the surface form at the hip (great trochanter) and knee. (The shaft of the femur has, of course, an important influence as a hidden inner axis on the overall length of this form.)

The thigh has a diagonal attachment into the pelvic structure of the torso, low at its inner pubic connection and rising to the iliac crest at the outer side of the figure. This may be traced from the obvious marking of the inguinal ligament (Poupart's ligament; see illustration 5-41) below the abdomen from the crest of the ilium to the pubic symphysis (see illustrations 7-11 and 7-17). This ligament overlaps the adductor muscles and sets an oblique direction of importance in describing the wedgelike surface below. The adductors form a somewhat conical unit interrupted by the sartorius [7-5, 7-6]. From a common origin in the pubic region of the pelvis, the adductors fan out along the shaft of the femur and, with the gracilis, shape the inner form and contour of the thigh.

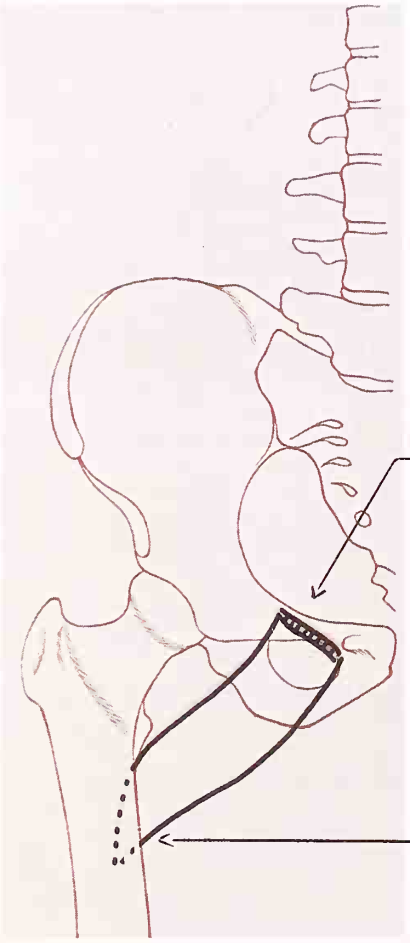
7-4
Pectineus Muscle.

This muscle adducts the thigh and rotates it outward.

7-5
Adductor Muscles of the Thigh, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The adductor magnus adducts the thigh (draws it inward) and rotates it.

7-4



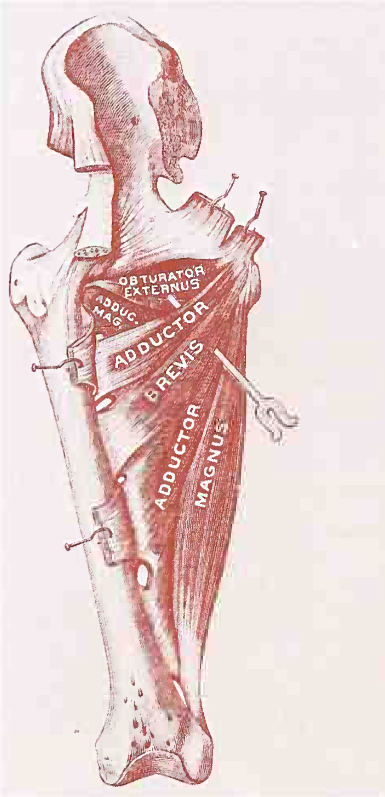
ORIGIN

FROM ILIO-
PECTINEAL LINE
OF THE RAMUS
OF THE PUBIC BONE

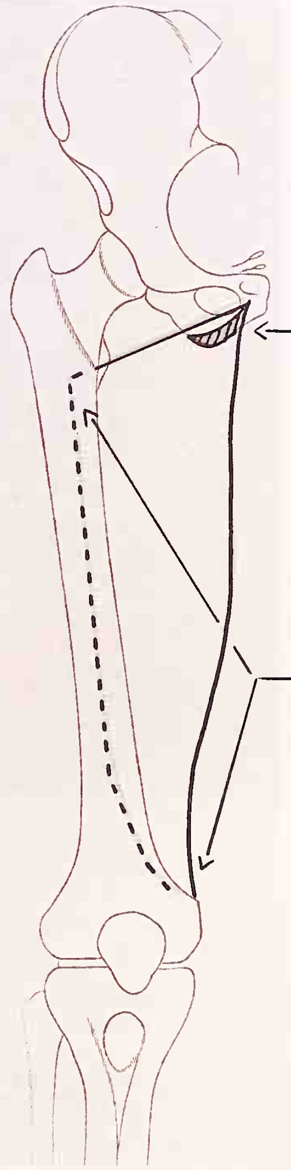
INSERTION

INTO LINEA ASPERA OF
UPPER SHAFT OF FEMUR

ADDUCTOR MAGNUS AND ADDUCTOR BREVIS



7-5



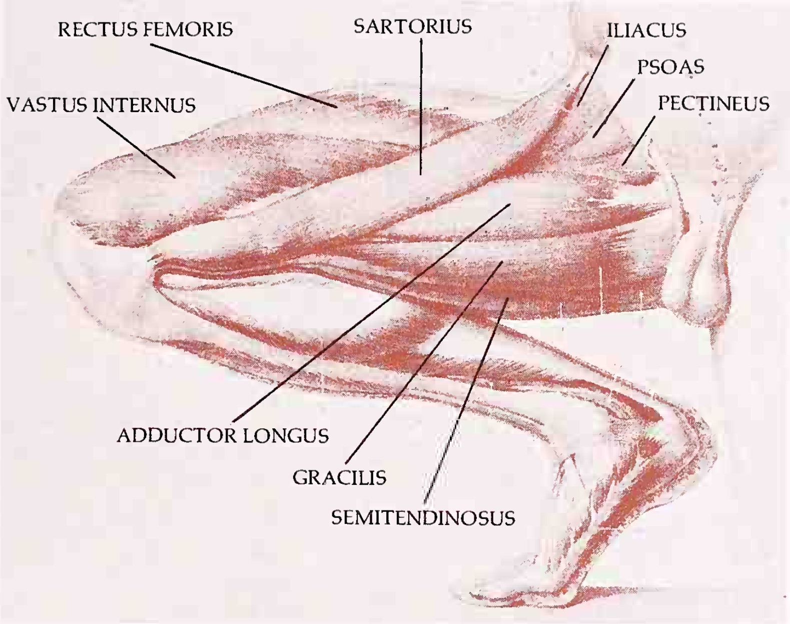
ORIGIN

FROM THE LOWER
RAMUS OF THE PUBIC
BONE AND THE
ISCHIUM

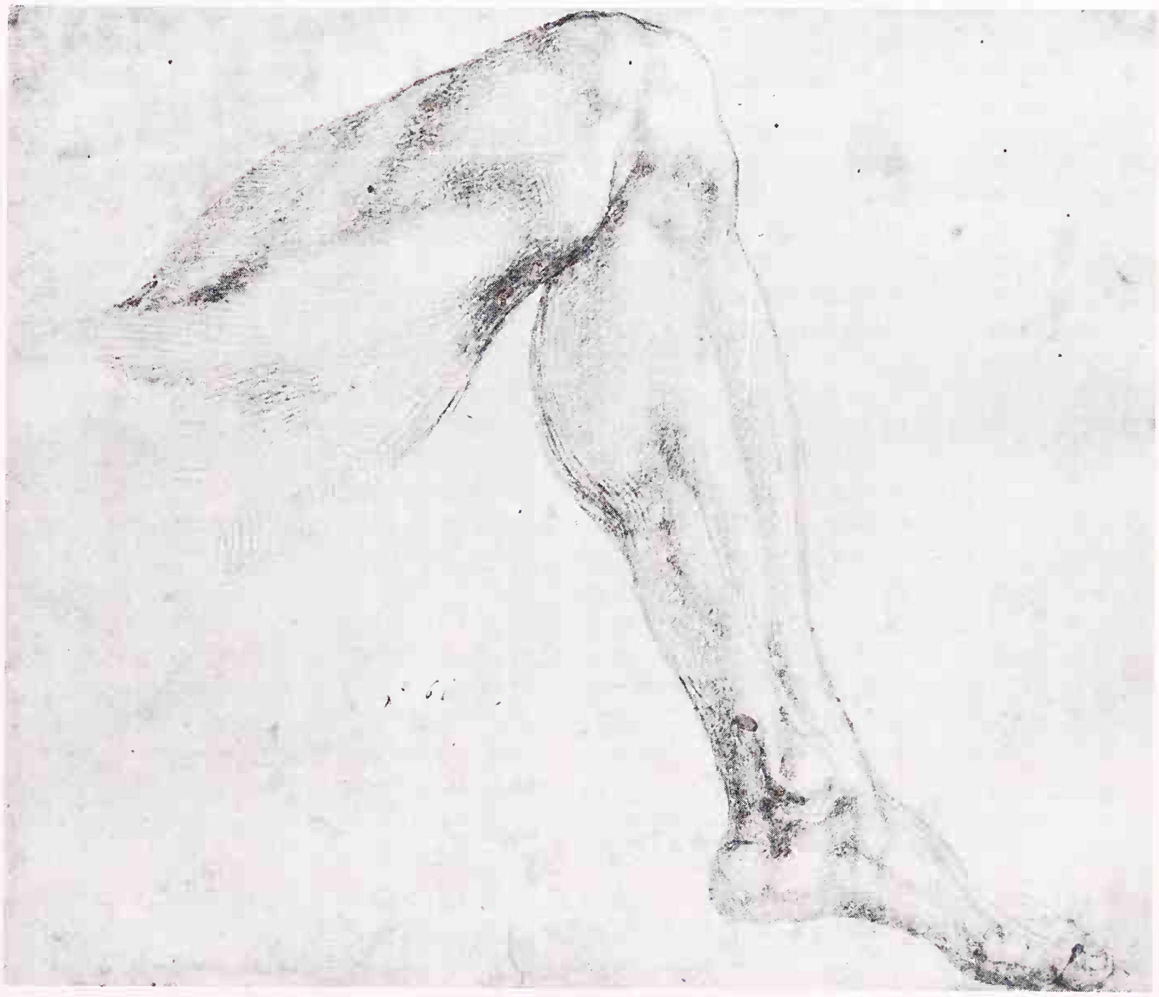
INSERTION

WHOLE REAR LENGTH
OF THE SHAFT OF THE
FEMUR ALONG THE
LINEA ASPERA TO
THE INNER CONDYLE

ADDUCTOR MAGNUS


RECTUS FEMORIS
SARTORIUS
ILIACUS
PSOAS
VASTUS INTERNUS
PECTINEUS
ADDUCTOR LONGUS
GRACILIS
SEMITENDINOSUS

7-6



7-7

7-6

Muscles of the Inner Thigh, from Anatomie of the External Forms of Man by Julian Fau. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

In this admirably clear lithograph, the influence of the sartorius muscle may be seen as the diagonal division between the quadriceps femoris and the adductors of the inner thigh. Compare this anatomical study with the drawing by Michelangelo [7-7].

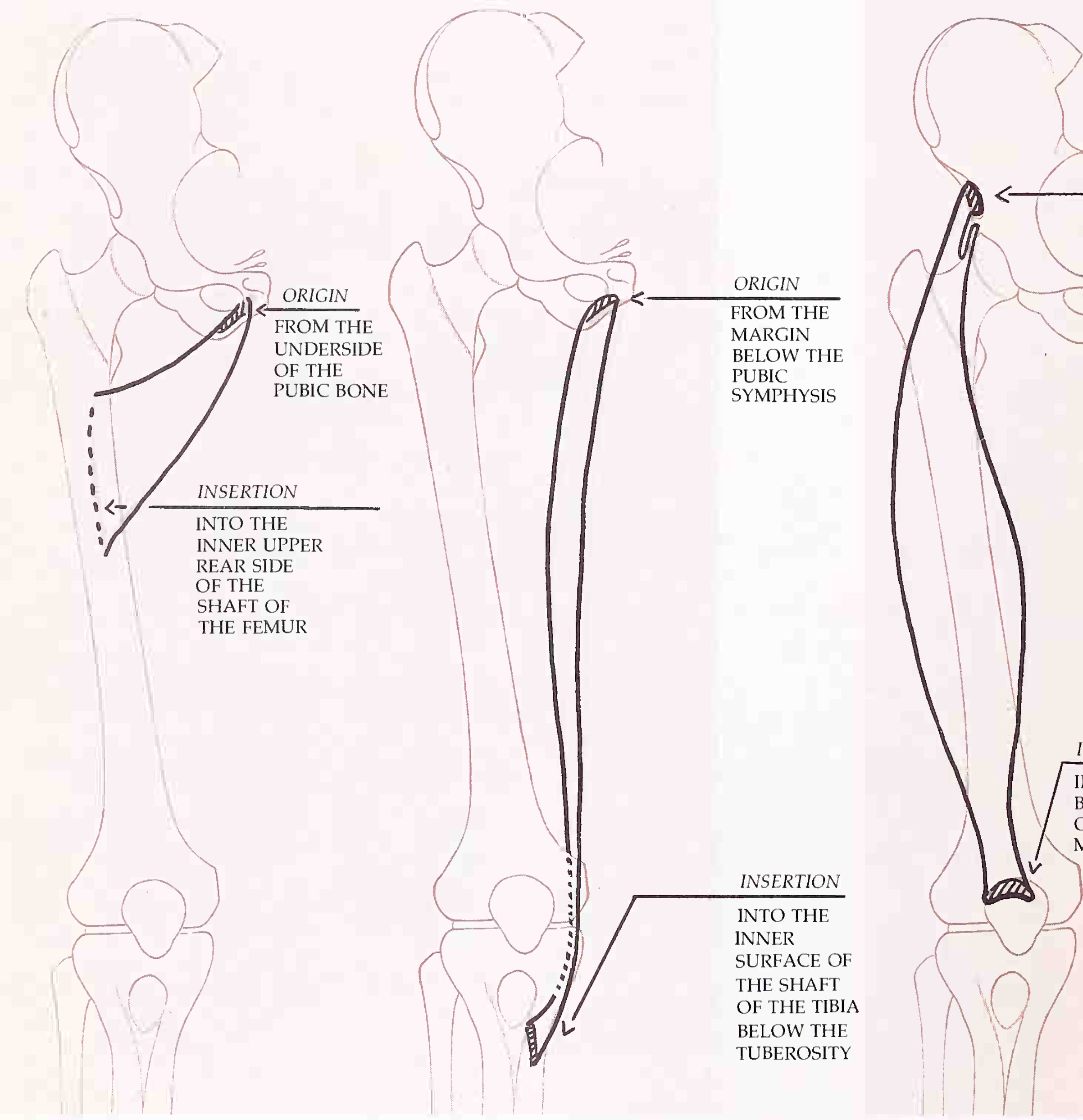
7-7

Study of the Inner Side of the Thigh and Leg by Michelangelo. (Teylers Stichting, Haarlem.)

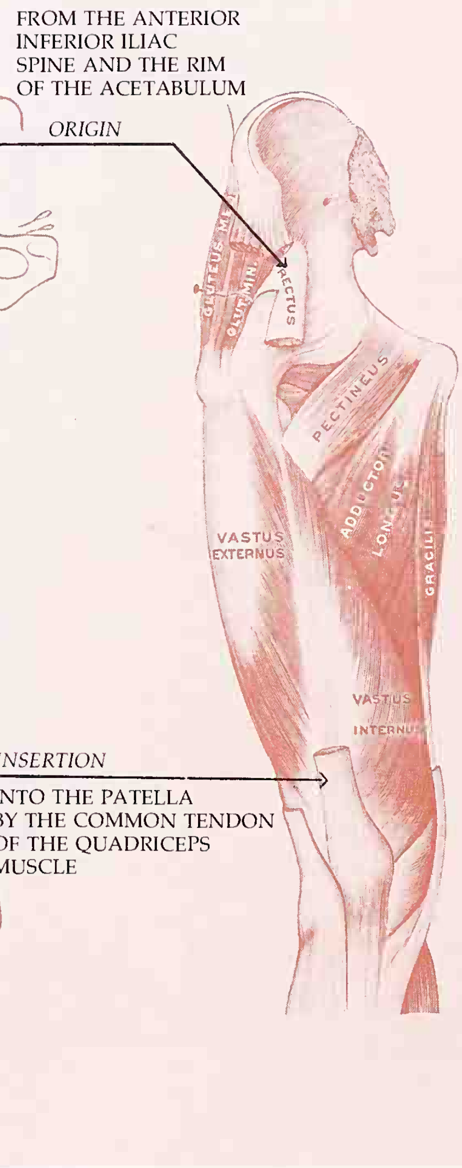
Compare this study with the preceding illustration to note the parts of the quadriceps femoris, the sartorius, and the adductors, as well as the clear forms of the calf.

The ribbonlike sartorius, the longest muscle, effects a sharp division through the length of the thigh [7-6, 7-16]. Running diagonally from the front crest of the ilium to the internal tuberosity of the tibia, it clearly separates two important groups of muscles: the adductor group (filling out the inner and upper thigh) and the powerful extensors (quadriceps femoris) of the front plane [7-11].

7-8


ORIGIN
FROM THE UNDERSIDE OF THE PUBIC BONE
INSERTION
INTO THE INNER UPPER REAR SIDE OF THE SHAFT OF THE FEMUR
ORIGIN
FROM THE MARGIN BELOW THE PUBIC SYMPHYSIS
INSERTION
INTO THE INNER SURFACE OF THE SHAFT OF THE TIBIA BELOW THE TUBEROSITY

ADDUCTOR BREVIS **GRACILIS** **RECTUS FEMORIS**


FROM THE ANTERIOR INFERIOR ILIAC SPINE AND THE RIM OF THE ACETABULUM
ORIGIN
GLUTEUS ME
GLUT. MIN.
RECTUS
PECTINEUS
VASTUS EXTERNUS
ADDUCTOR LONGUS
GRACILIS
VASTUS INTERNUS
INSERTION
INTO THE PATELLA BY THE COMMON TENDON OF THE QUADRICEPS MUSCLE

7-9

7-8
Gracilis and Adductor Brevis.

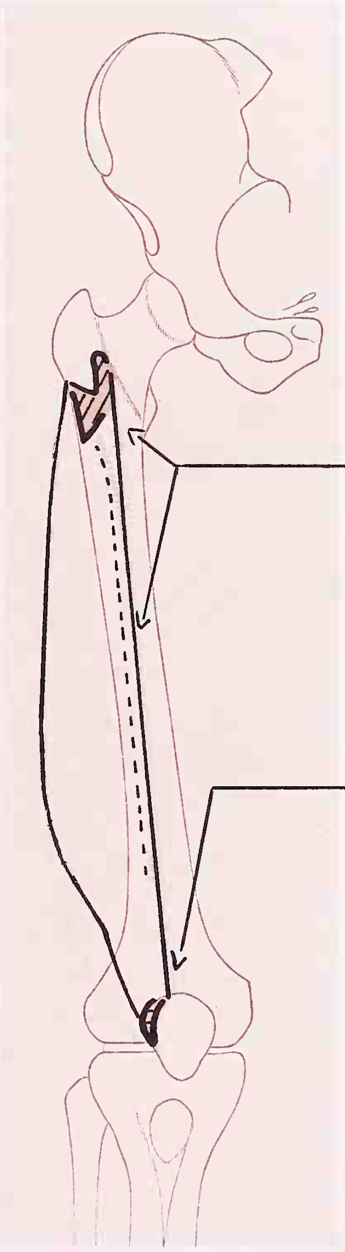
The gracilis flexes the leg, adducts the thigh, and rotates the leg inward. The adductor brevis adducts the thigh.

7-9
Muscles of the Thigh, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The rectus femoris extends the leg.

7-10
Vastus Externus and Vastus Internus. (Photograph by Iso Papo.)

Both of these muscles extend the leg.



ORIGIN

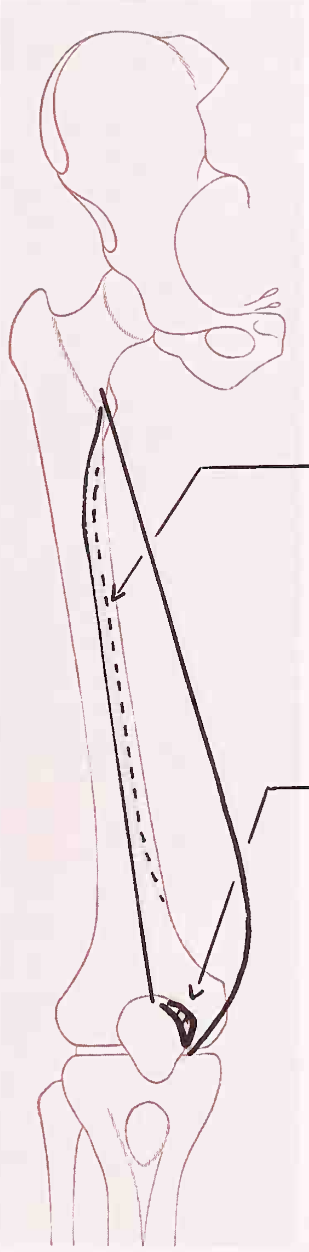
FROM THE FRONT BORDER OF THE GREAT TROCHANTER AND THE OUTER SIDE OF THE LINEA ASPERA ALONG THE REAR LENGTH OF THE SHAFT OF THE FEMUR

INSERTION

INTO THE OUTER SIDE OF THE PATELLA BY THE COMMON FLAT TENDON OF THE QUADRICEPS MUSCLE

VASTUS EXTERNUS

7-10



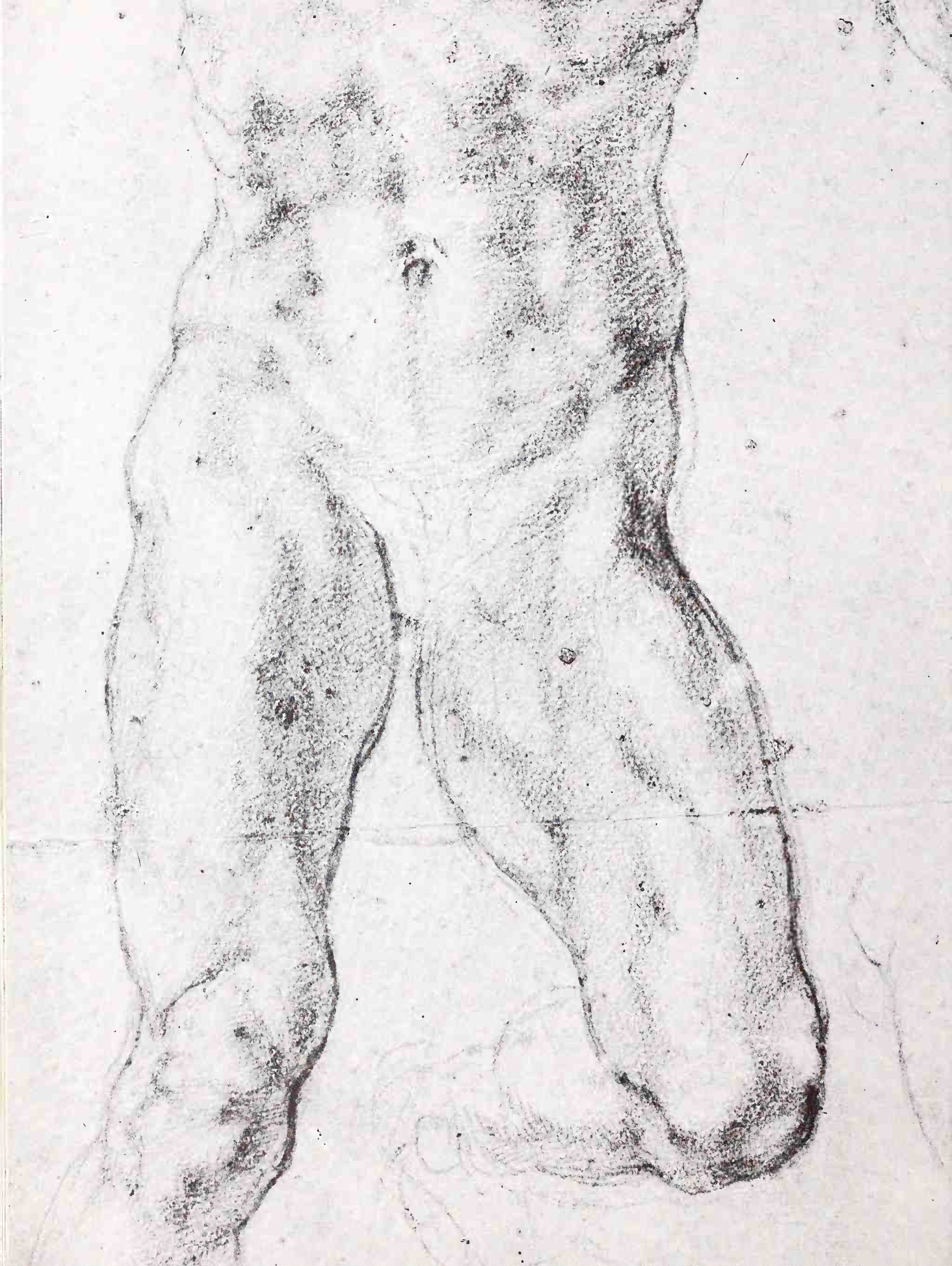
ORIGIN

FROM THE FRONT EDGE OF THE LESSER TROCHANTER AND THE LENGTH OF THE INNER BORDER OF THE LINEA ASPERA ALONG THE REAR SURFACE OF THE SHAFT OF THE FEMUR

INSERTION

INTO THE INNER BORDER OF THE PATELLA BY THE COMMON FLAT TENDON OF THE QUADRICEPS MUSCLE

VASTUS INTERNUS



7-11
Detail of the Thigh and Hip, from The Figure of Haman by Michelangelo. (Courtesy: Trustees of the British Museum.)

Observe the diagonal attachment of the thigh into the hip from the pubic symphysis to the crest of the ilium. The long, tense sartorius muscle is clearly visible in the right leg, running from the hip to the inner knee and separating two groups of muscle: the adductors of the inner thigh from the quadriceps femoris. (See 5-37 for a reproduction of the entire drawing.)

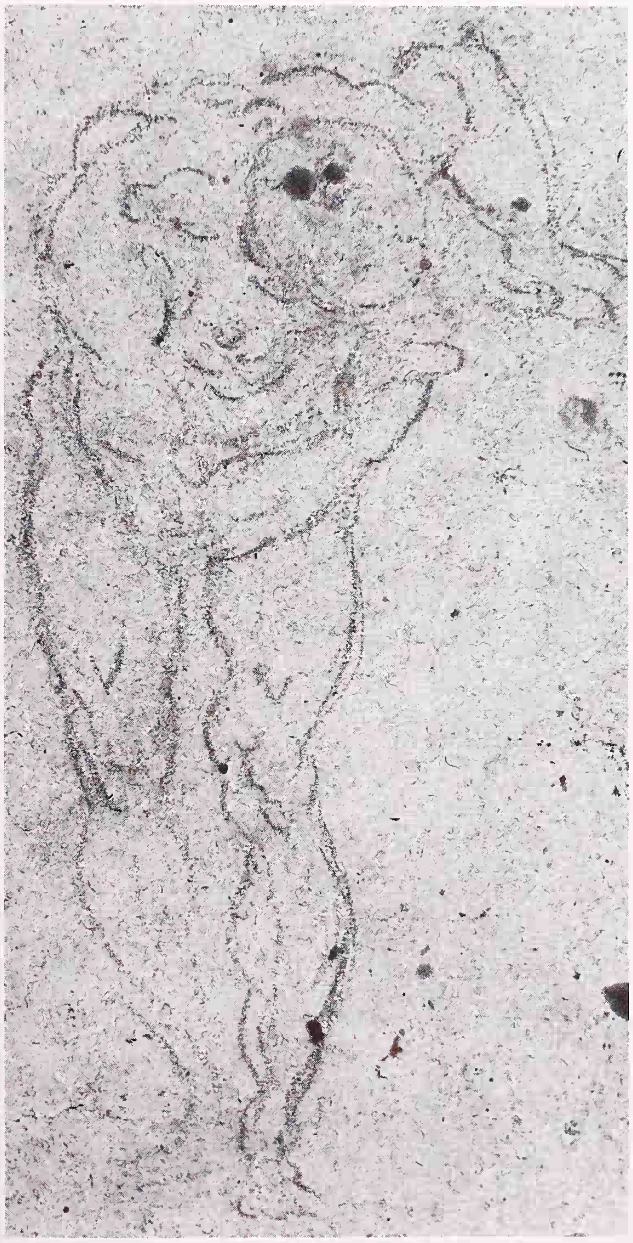
The front plane of the thigh is dominated by a four-part muscle, the quadriceps femoris. Three parts are clearly marked in a well-developed limb [7-9]. The fourth (crureus) is a deep, indirect influence on the front surface of the thigh. The quadriceps femoris is visible the full length of the form, and its influence is paramount in giving character to the thigh [7-11]. The rectus femoris portion [7-9] from its origin above at the front of the pelvis emerges between two muscles, the tensor fasciae latae and the sartorius, and follows closely the diagonal axis of the femur bone. It is flanked on the outer side of the thigh by the vastus externus (high) and on the inner thigh by the vastus internus, the latter filling out lower, just above the knee. Both originate on the rear femur shaft. All three parts insert into a common tendon flowing into and over the patella. The key structural relationships of the thigh are seen in the Pontormo drawing [7-13] and the accompanying diagram [7-14].

7-12
Figure Bending Forward by Domenico Tintoretto (National Gallery of Scotland.)

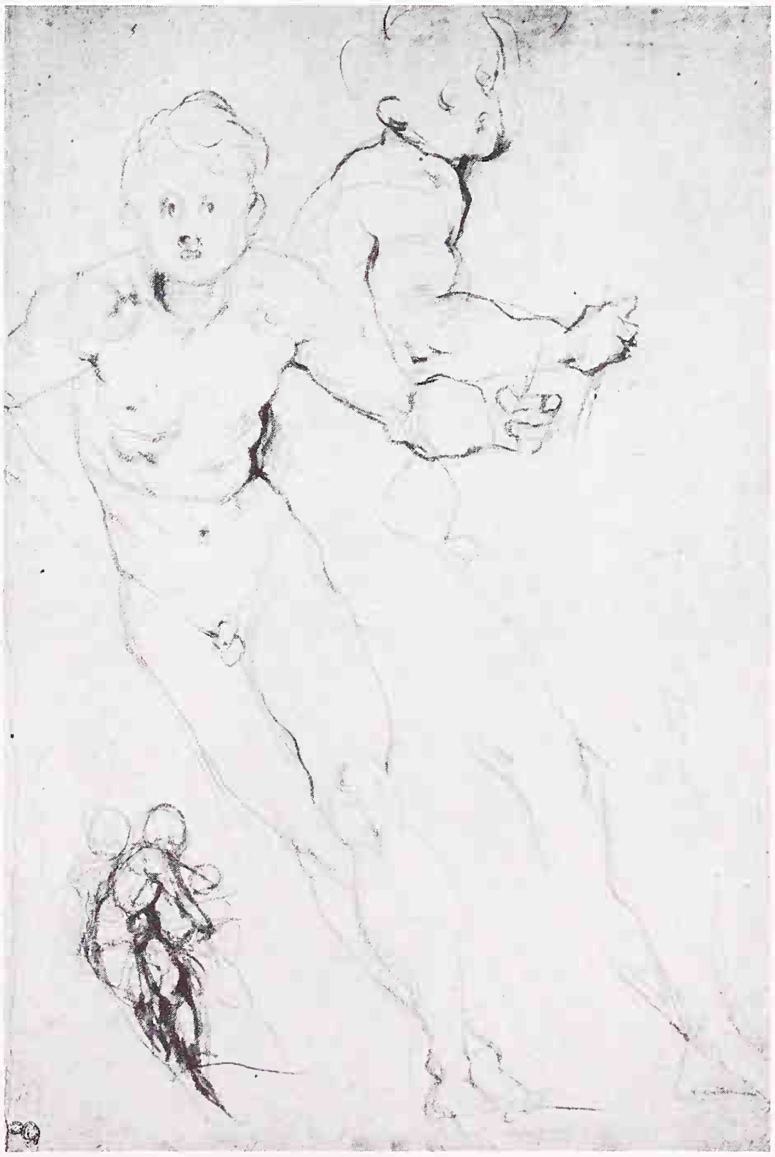
Compare this study with the drawing by Raphael da Montelupo [7-2].

7-13
Study of Two Youths by Jacopo da Pontormo. (Fogg Art Museum, Harvard University; Bequest of Charles Alexander Loeser.)

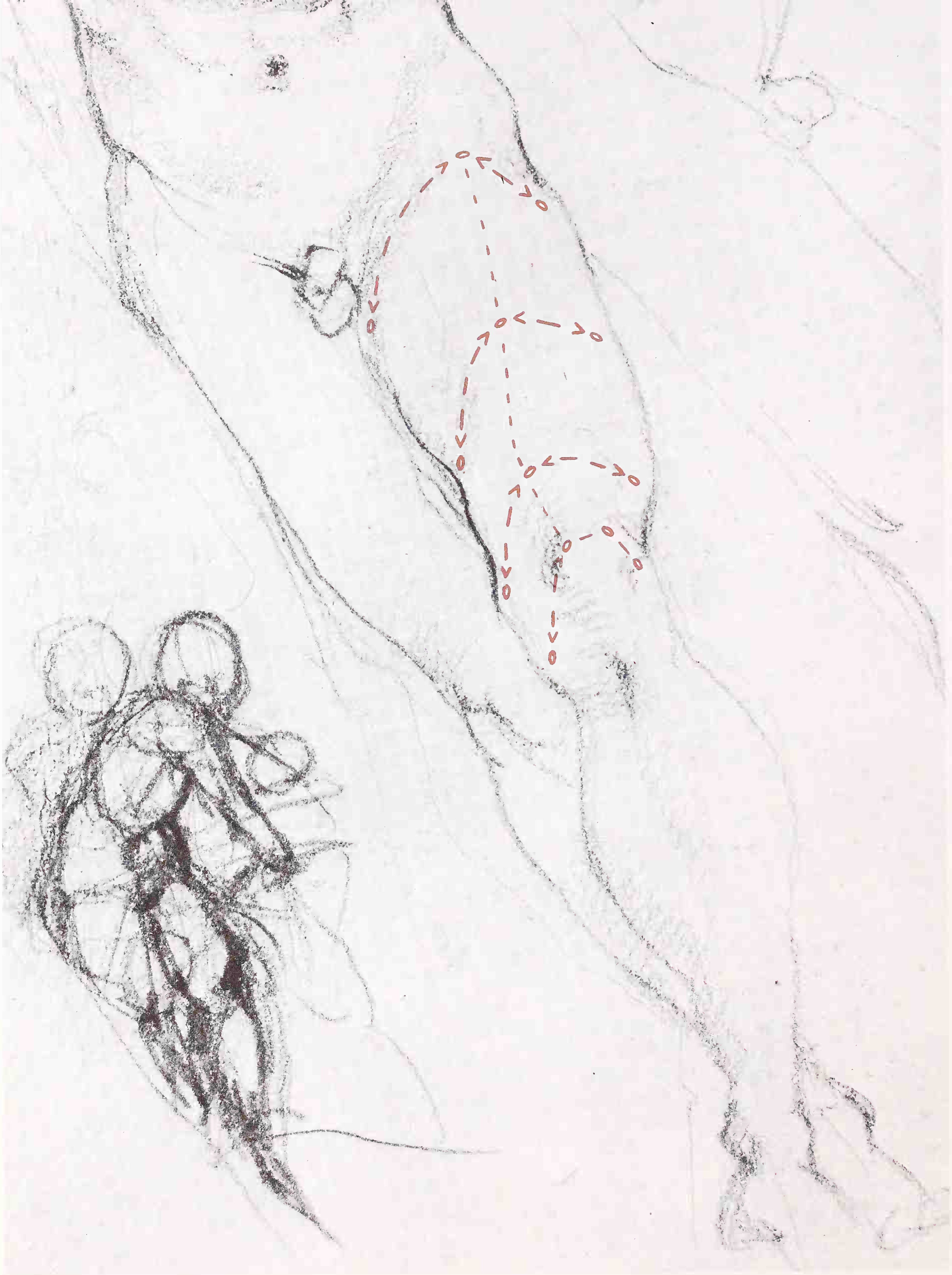
See the analysis of the planes of the thigh in illustration 7-14.



7-12



7-13



7-14

7-14

Detail of Study of Two Youths by Jacopo da Pontormo.

In this study, essentially a line drawing, a few pertinent indications of tone and line within the form identify key structural relationships. The dotted line running the length of the thigh identifies the height of the mid-form joining the two broad surfaces of the front and inner volume.

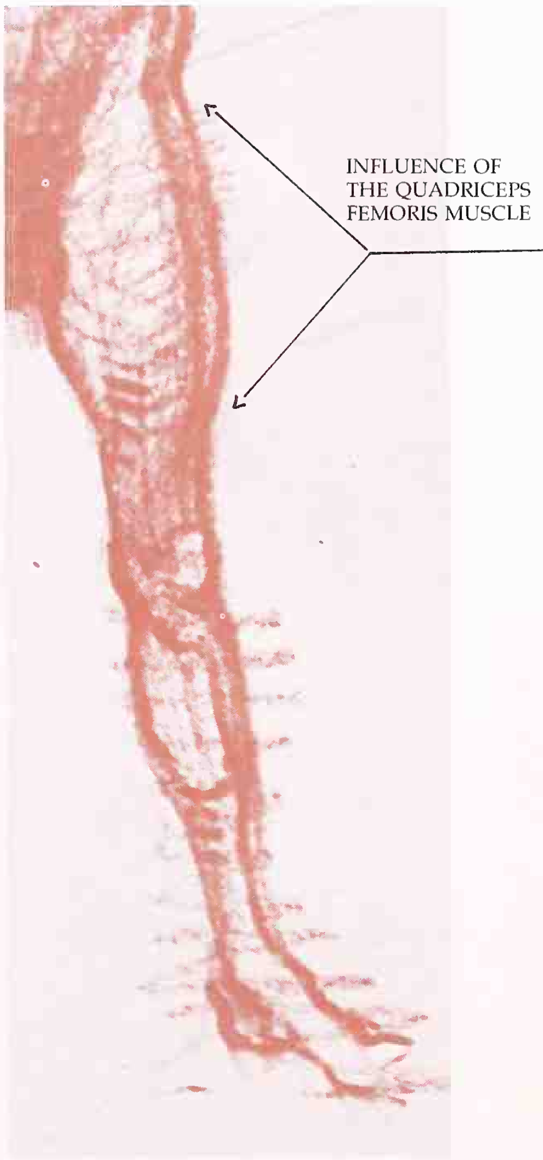
7-15

Detail of the Lower Extremity from a Figure Drawing by the author. (Photograph by Kalman Zabarsky.)

7-16

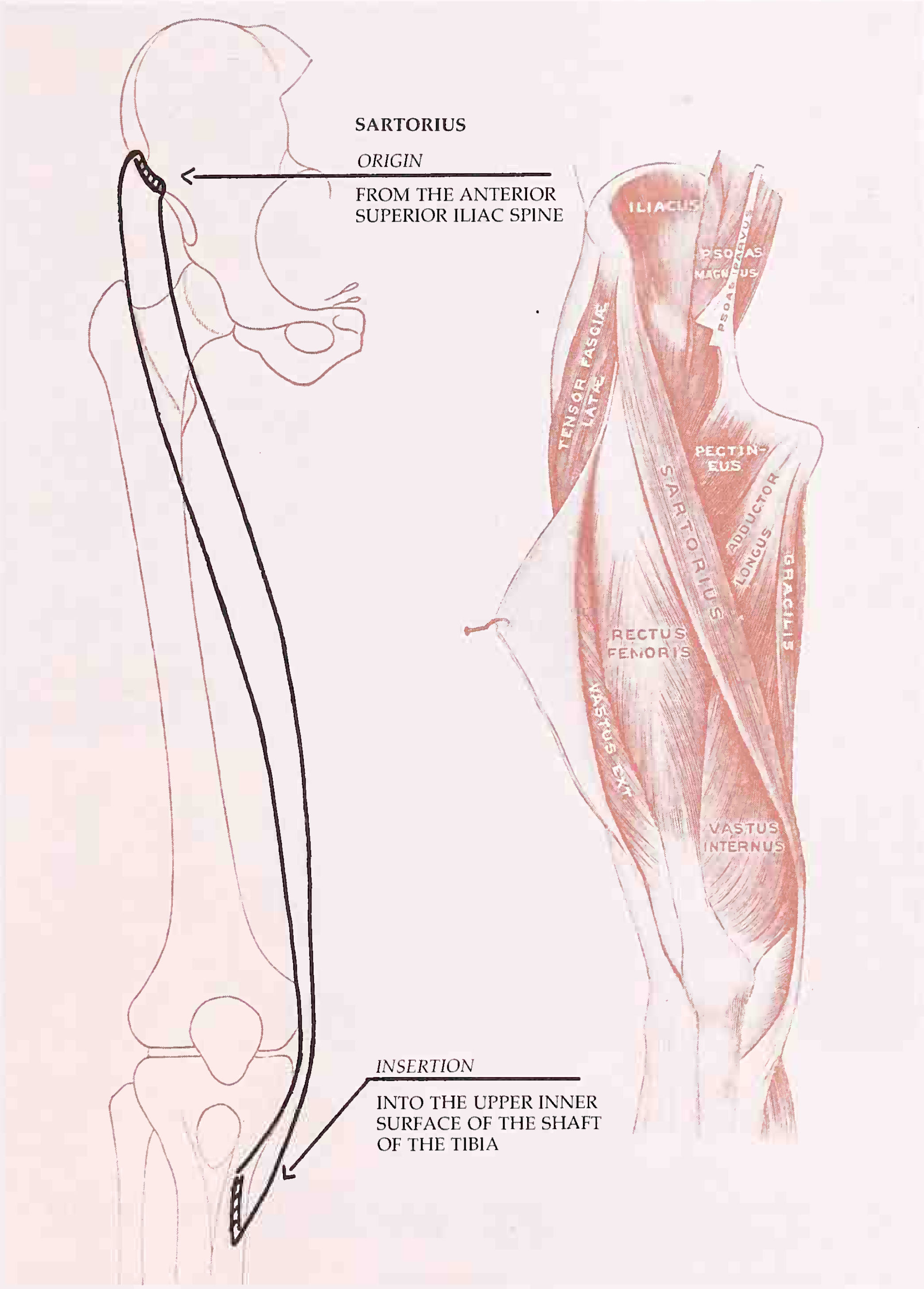
Muscles of the Thigh, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The sartorius flexes and crosses the legs and rotates the thigh outward.

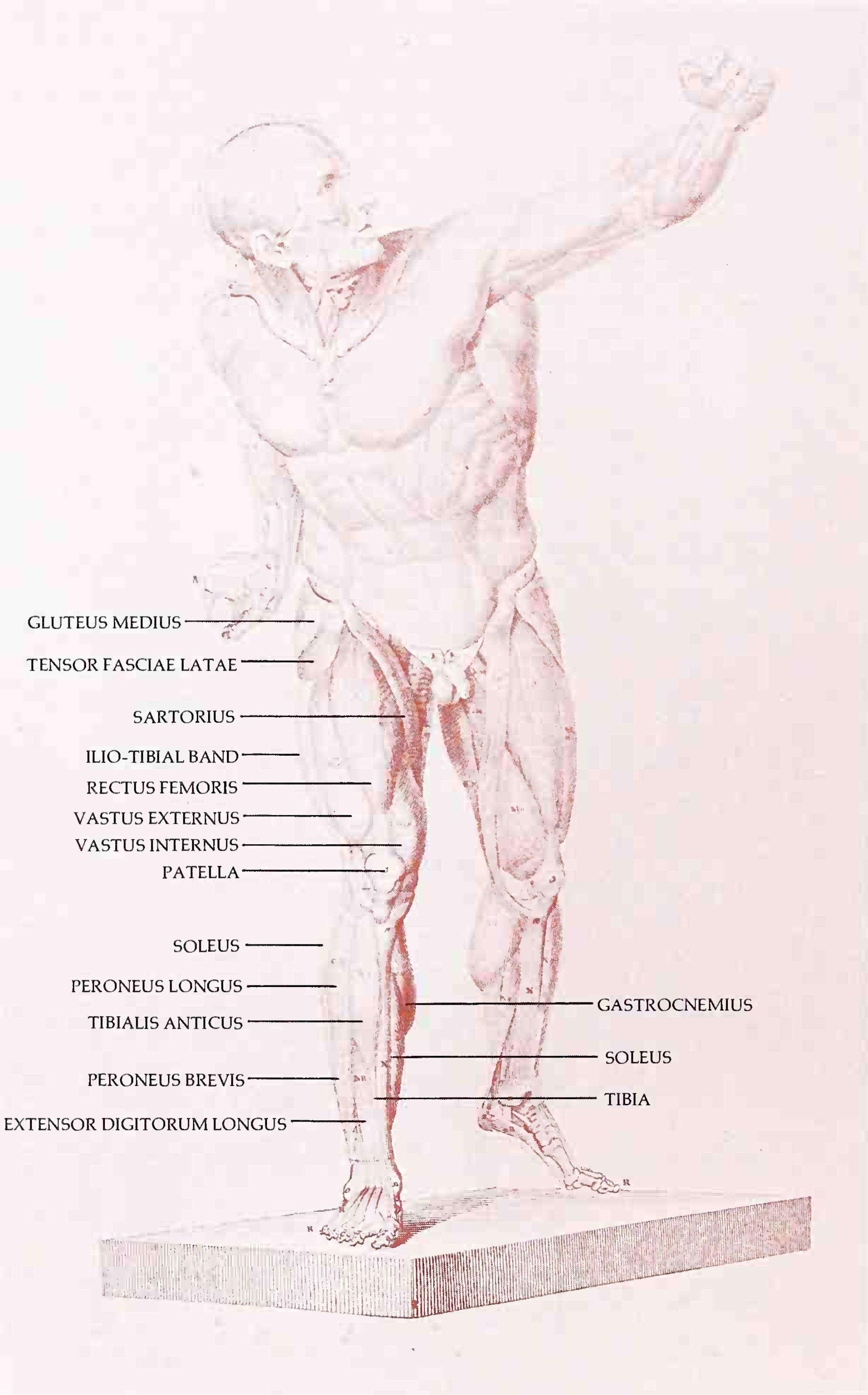

INFLUENCE OF
THE QUADRICEPS
FEMORIS MUSCLE

7-15

SARTORIUS


SARTORIUS
ORIGIN
FROM THE ANTERIOR
SUPERIOR ILIAC SPINE
INSERTION
INTO THE UPPER INNER
SURFACE OF THE SHAFT
OF THE TIBIA
ILIACUS
PSOAS PARVUS
PSOAS MAGNUS
TENSOR FASCIÆ LATÆ
PECTINEUS
SARTORIUS
ADDUCTOR LONGUS
GRACILIS
RECTUS FEMORIS
VASTUS EXT.
VASTUS INTERNUS

7-16

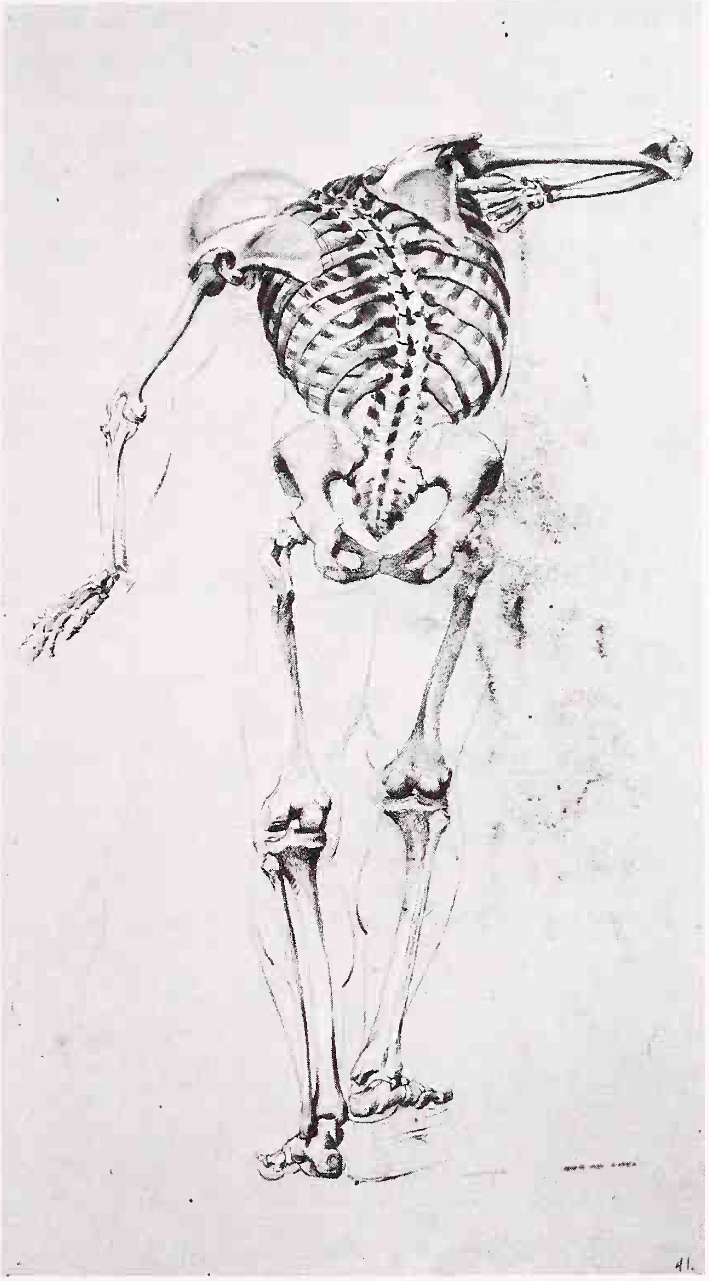

GLUTEUS MEDIUS
TENSOR FASCIAE LATAE
SARTORIUS
ILIO-TIBIAL BAND
RECTUS FEMORIS
VASTUS EXTERNUS
VASTUS INTERNUS
PATELLA
SOLEUS
PERONEUS LONGUS
TIBIALIS ANTICUS
PERONEUS BREVIS
EXTENSOR DIGITORUM LONGUS
GASTROCNEMIUS
SOLEUS
TIBIA

7-17

7-17

Front View of the Borghese Fighter, from Anatomy of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

In this illustration the muscles of the leg are labeled for study.



7-18

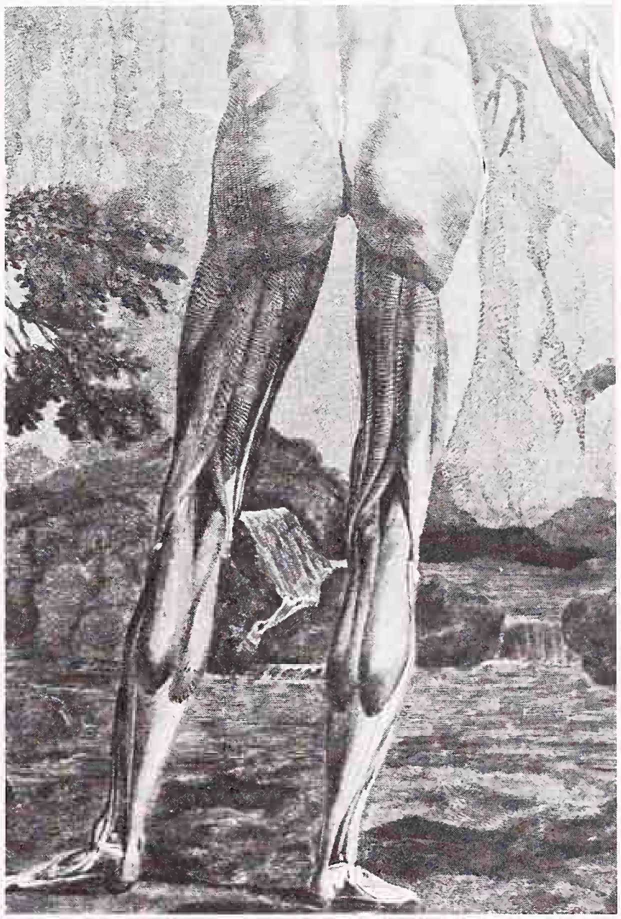
7-18

Skeleton Study (chalk and pencil, 1848) by Daniel Huntington. (In The Brooklyn Museum Collection; Gift of the Roebling Society.)

7-19

Detail of the Legs, from Muscles of the Back from Tables of the Skeleton and Muscles of the Human Body by Bernhard Albinus. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

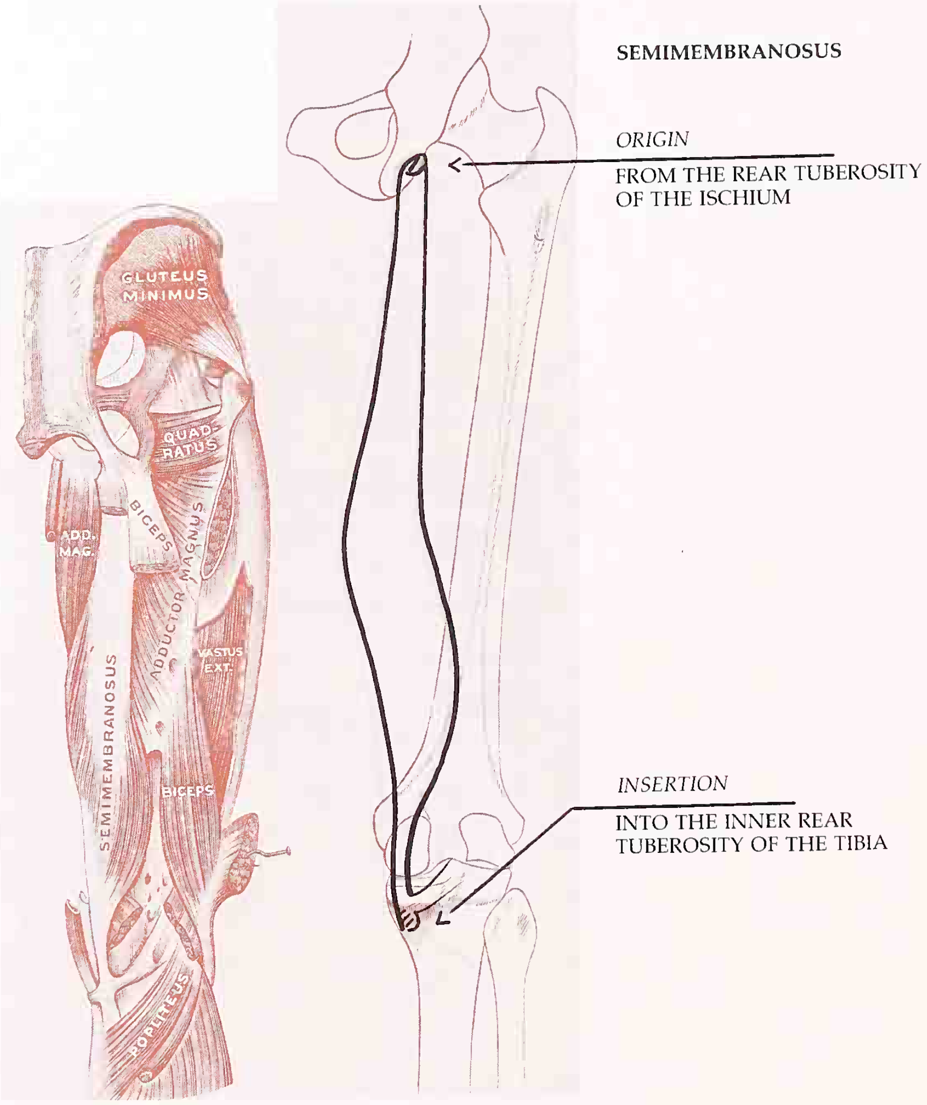
The continuity of form over an articulation is well illustrated in the back of the leg. The tendons of the hamstring muscles slip outside to the head of the fibula and the internal tuberosity of the tibia. The two enlarged bellies of the gastrocnemius originate between, at the rear condyles of the femur. This interlocking relationship should not be compromised by the creases at the back of the leg behind the knee. Compare this with the drawing by Pontormo [5-13].



7-19

The back of the thigh [7-20, 7-21, 7-22] is formed by the three hamstring muscles: the semitendinosus (above), the semimembranosus (below) at the inner form, and the biceps femoris, with a long and a short head on the outer side. As a group these muscles extend the full length of the form, originating from the ischial tuberosity of the pelvis. They are distinguished at their lower insertion (tibia-fibula) by sharply evident, stringlike tendons that frame both sides of the rear knee articulation [7-20, 7-21, 7-22].

The two heads of the gastrocnemius (calf muscle) fill out part of the space between


GLUTEUS MINIMUS
QUAD. RATUS
ADD. MAG.
BICEPS
ADDUCTOR MAGNUS
VASTUS EXT.
SEMIMEMBRANOSUS
BICEPS
POPLITEUS
SEMIMEMBRANOSUS
ORIGIN
FROM THE REAR TUBEROSITY OF THE ISCHIUM
INSERTION
INTO THE INNER REAR TUBEROSITY OF THE TIBIA

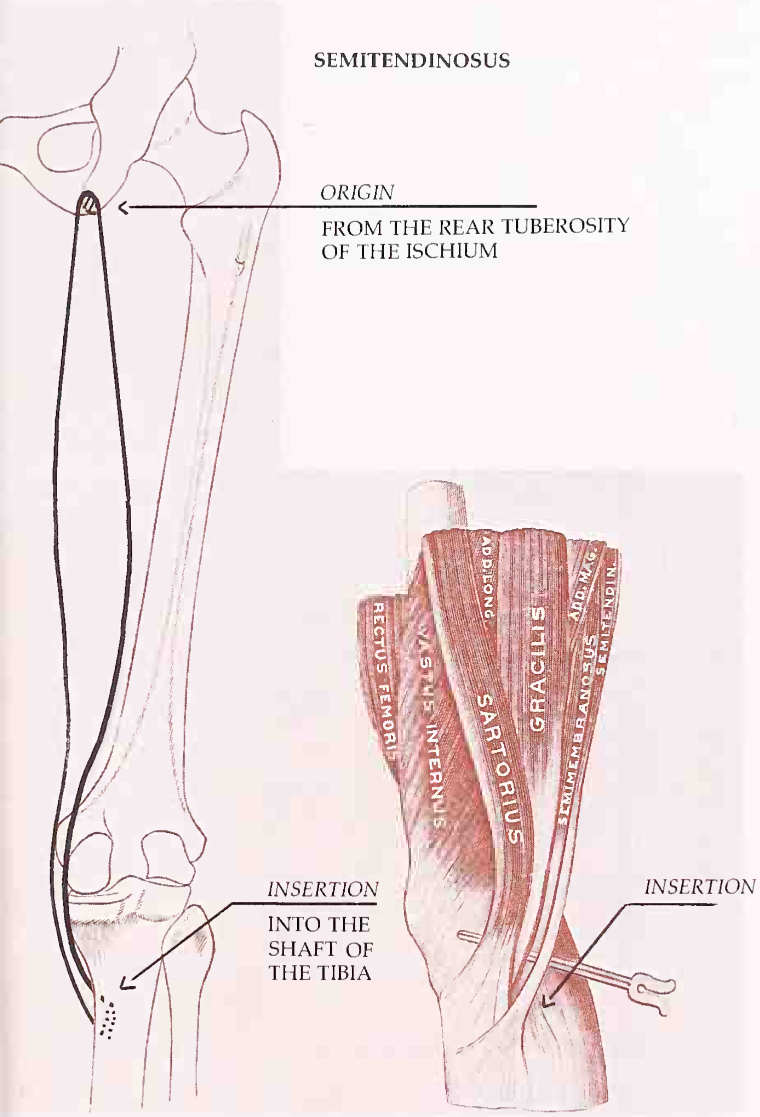
7-20

7-20
Hamstring Muscles, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The semimembranosus flexes the leg and rotates it inward.

the hamstring tendons. Their connection into the back of the femur is disguised and slightly interrupted by a crease at this articulation, but they should be understood as continuing through this superficial marking (see illustration 7-36).

The remaining smaller superficial muscles of the thigh to be carefully studied are the tensor fasciae latae (plus the important ilio-tibial band) on the outer side of the hip and thigh [7-17, 7-23] and the partly visible pectineus and ilio-psoas below the inguinal ligament.


RECTUS FEMORIS
VASTUS INTERNUS
ADD. LONG.
SARTORIUS
GRACILIS
ADD. MAG.
SEMIMEMBRANOSUS
SEMITENDIN.

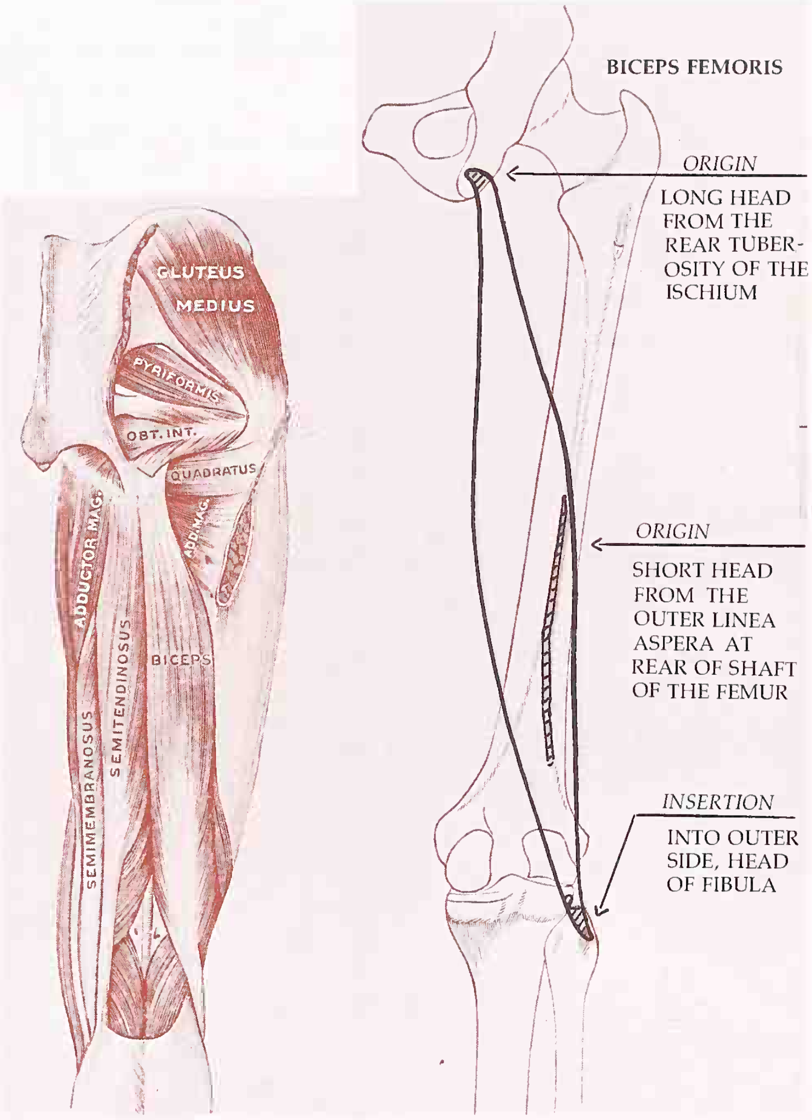
SEMITENDINOSUS

ORIGIN
FROM THE REAR TUBEROSITY OF THE ISCHIUM

INSERTION
INTO THE SHAFT OF THE TIBIA

INSERTION

7-21


GLUTEUS MEDIUS
PYRIFORMIS
OBT. INT.
QUADRATUS
ADD. MAG.
ADDUCTOR MAG.
SEMITENDINOSUS
BICEPS
SEMIMEMBRANOSUS

BICEPS FEMORIS

ORIGIN
LONG HEAD FROM THE REAR TUBEROSITY OF THE ISCHIUM

ORIGIN
SHORT HEAD FROM THE OUTER LINEA ASPERA AT REAR OF SHAFT OF THE FEMUR

INSERTION
INTO OUTER SIDE, HEAD OF FIBULA

7-22

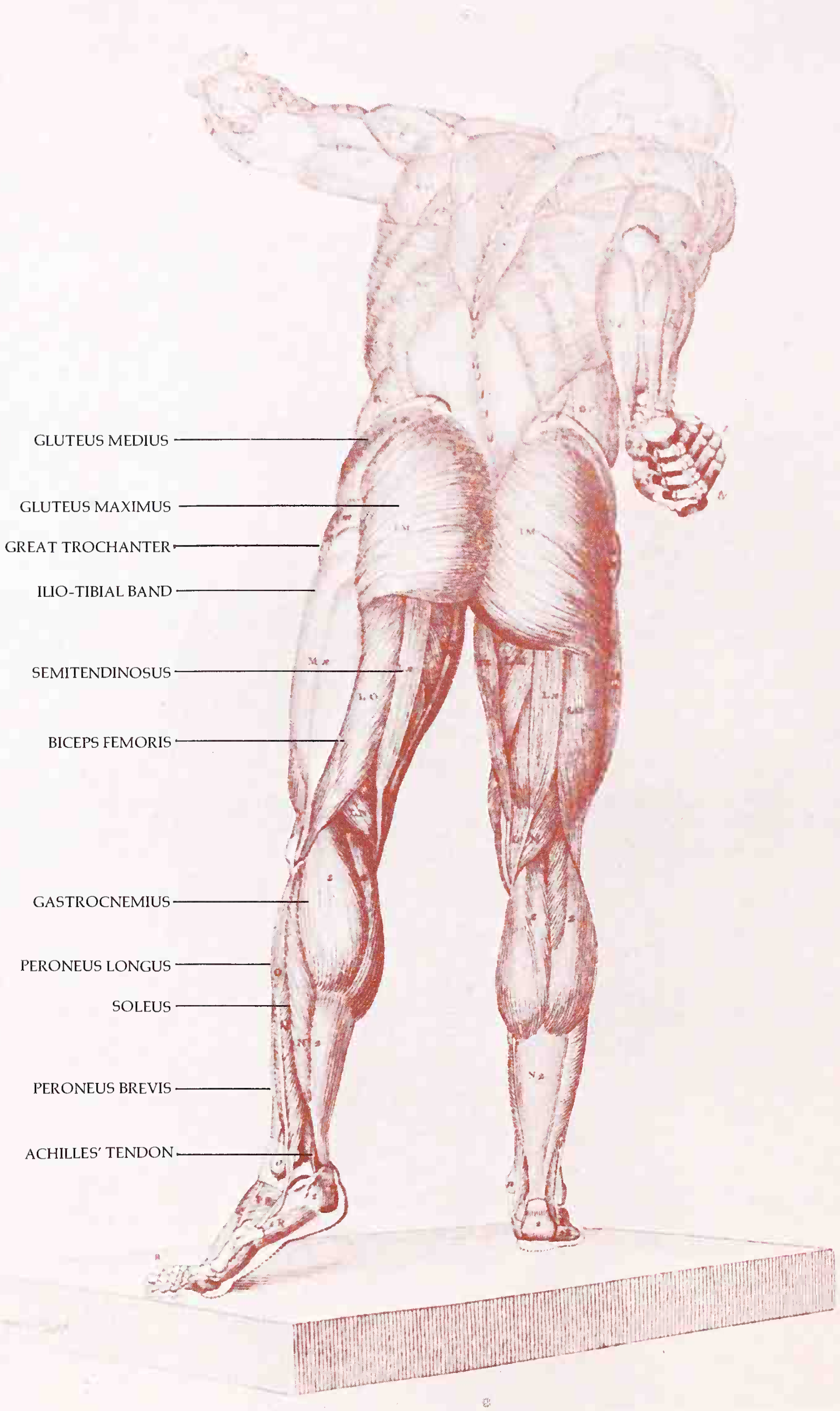
7-21
Muscles of the Thigh, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The semitendinosus flexes the leg upon the thigh.

7-22
Inner Hamstring Muscles, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The action of the biceps femoris is to flex the leg and rotate it outward.

7-23

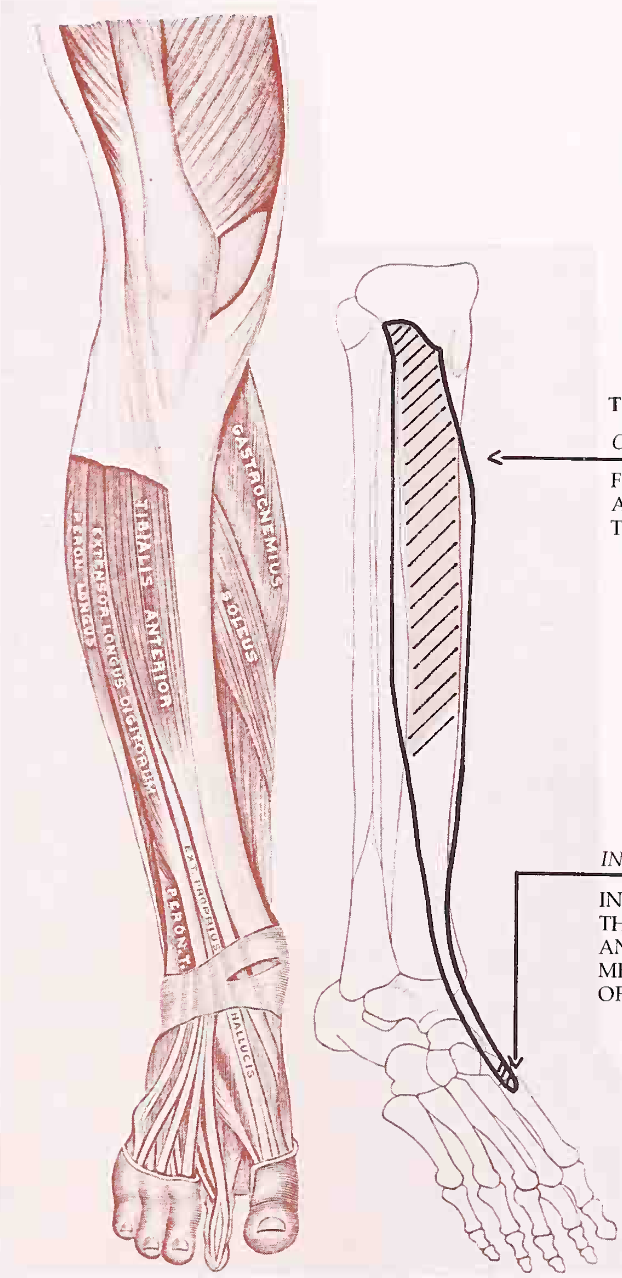

GLUTEUS MEDIUS
GLUTEUS MAXIMUS
GREAT TROCHANTER
ILIO-TIBIAL BAND
SEMITENDINOSUS
BICEPS FEMORIS
GASTROCNEMIUS
PERONEUS LONGUS
SOLEUS
PERONEUS BREVIS
ACHILLES' TENDON

7-23
Back View of the Borghese Fighter, from Anatomy of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

In this illustration the muscles of the thigh and leg as seen from the back are labeled for study.

THE CALF

In contrast to the muscles of the thigh and the well-padded shaft of the femur bone, the musculature of the lower leg is situated largely behind and to the side of the bones [7-27]. The crest of the tibia (shinbone) is exposed in front for its entire length. Here a sharp angular surface change is directly related to a bone from the knee to the inner ankle. This can be easily felt by running the fingers along the front of the lower leg. The fibula bone, long and thin, is exposed primarily at its lower ends as the outer ankle (outer malleolus). Its thin shaft is buried in muscle, but at the other side of the knee it surfaces again as a small, knoblike eminence. This can be easily identified with the finger.


GASTROCNEMIUS
SOLEUS
TIBIALIS ANTERIOR
EXTENSOR LONGUS DIGITORUM
PERON. LONGUS
EXT. PROPRIUS
PERON. T.
HALLUCIS

TIBIALIS ANTICUS (TIBIALIS ANTERIOR)

ORIGIN

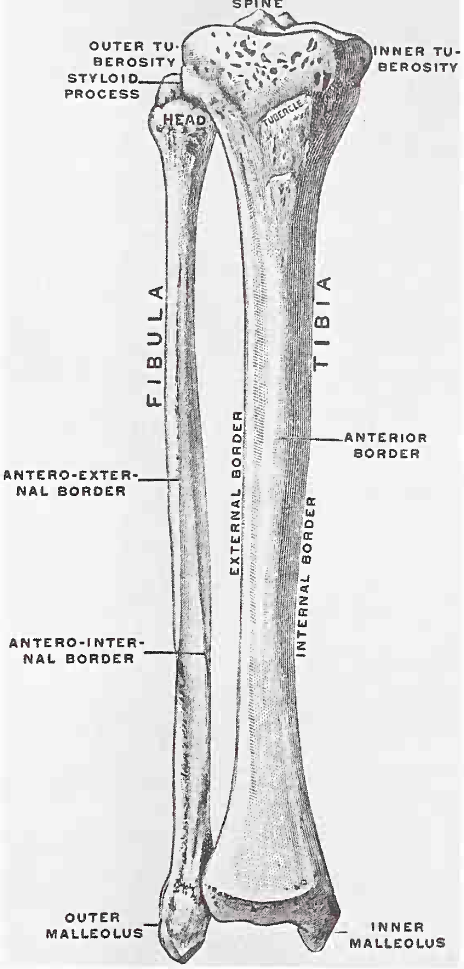
FROM THE OUTER TUBEROSITY
AND UPPER ⅔ OF
THE SHAFT OF THE TIBIA

INSERTION

INTO INNER SURFACE OF
THE INTERNAL CUNEIFORM
AND BASE OF THE FIRST
METATARSAL (METATARSAL
OF GREAT TOE)

7-26

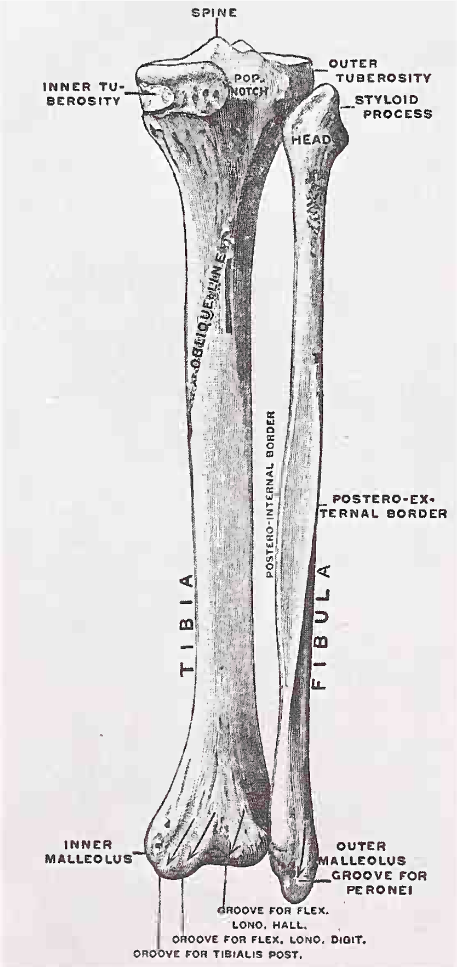
7-26
Muscles: Right Leg, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)
The tibialis anticus flexes the tarsus (foot) and elevates the inner border of the foot.


SPINE
OUTER TUBEROSITY
STYLOID PROCESS
HEAD
TUBERCLE
INNER TUBEROSITY
FIBULA
TIBIA
ANTERIOR BORDER
EXTERNAL BORDER
INTERNAL BORDER
ANTERO-EXTERNAL BORDER
ANTERO-INTERNAL BORDER
OUTER MALLEOLUS
INNER MALLEOLUS

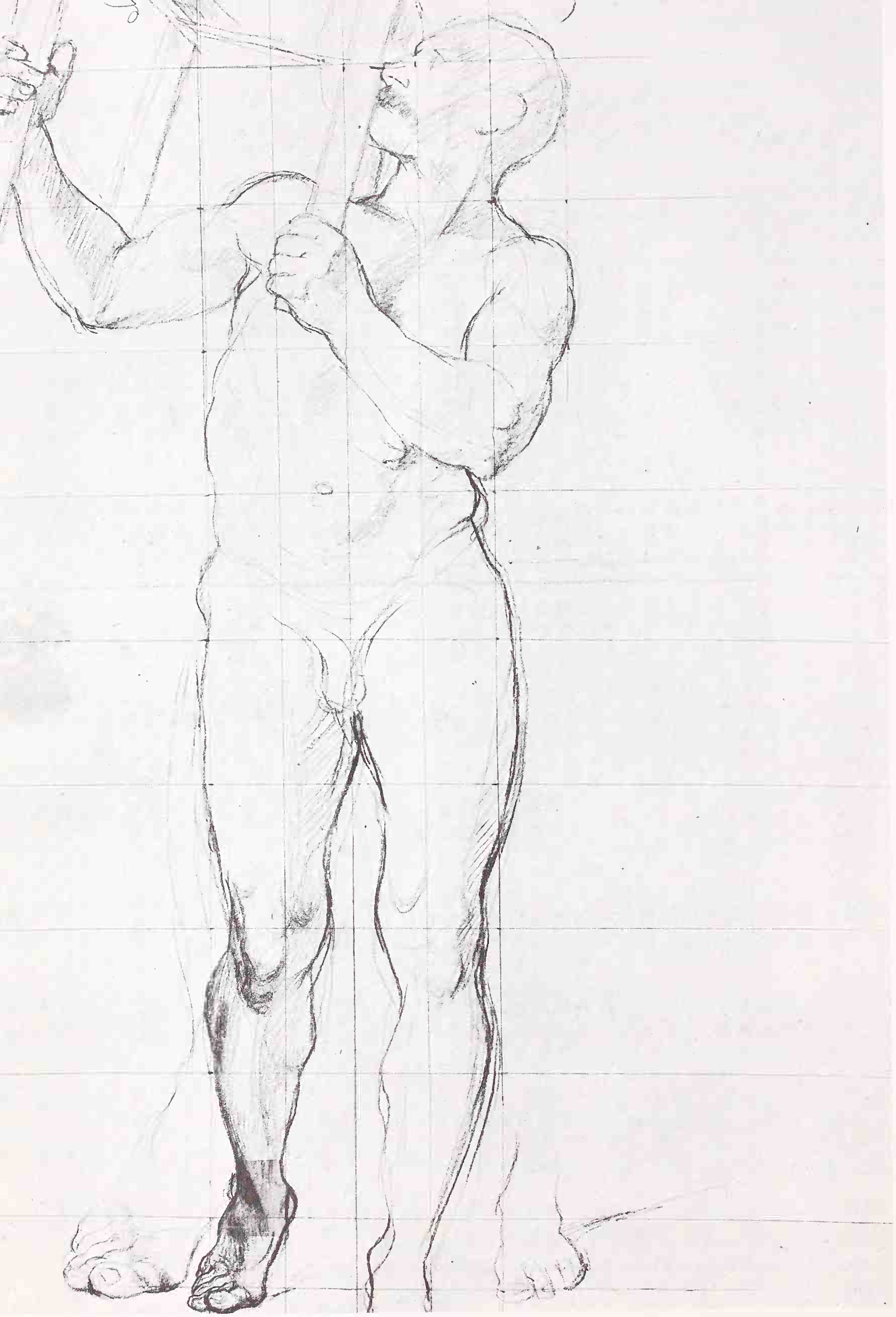
7-24

7-24
The Tibia and Fibula: Front View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

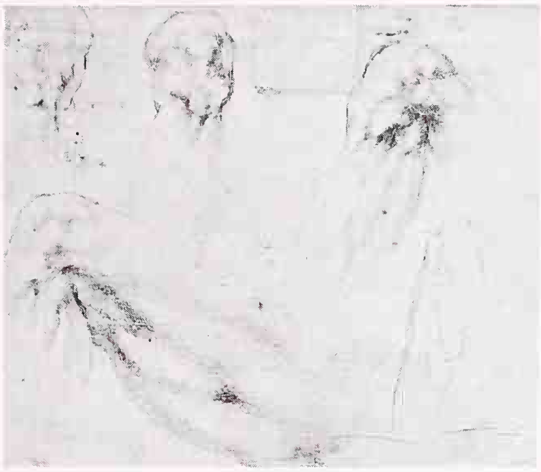
7-25
Tibia and Fibula: Rear View, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)


SPINE
INNER TUBEROSITY
POP. NOTCH
OUTER TUBEROSITY
STYLOID PROCESS
HEAD
OBLIQUE LINE
POSTERO-INTERNAL BORDER
POSTERO-EXTERNAL BORDER
TIBIA
FIBULA
INNER MALLEOLUS
OUTER MALLEOLUS
GROOVE FOR PERONEI
GROOVE FOR FLEX. LONG. HALL.
GROOVE FOR FLEX. LONG. DIGIT.
GROOVE FOR TIBIALIS POST.

7-25



7-27



7-28

7-27

Study of Nude Man Holding a Chair (black chalk) by Jean Dominique Ingres. (Courtesy: Nelson Gallery-Atkins Museum, Nelson Fund, Kansas City, Missouri.)

The lower leg, from the front, is dominated by the curved axial thrust of the shinbone (tibia) from the knee to the inner ankle. The muscles are to the side and behind the full length of this exposed shaft of bone.

7-28

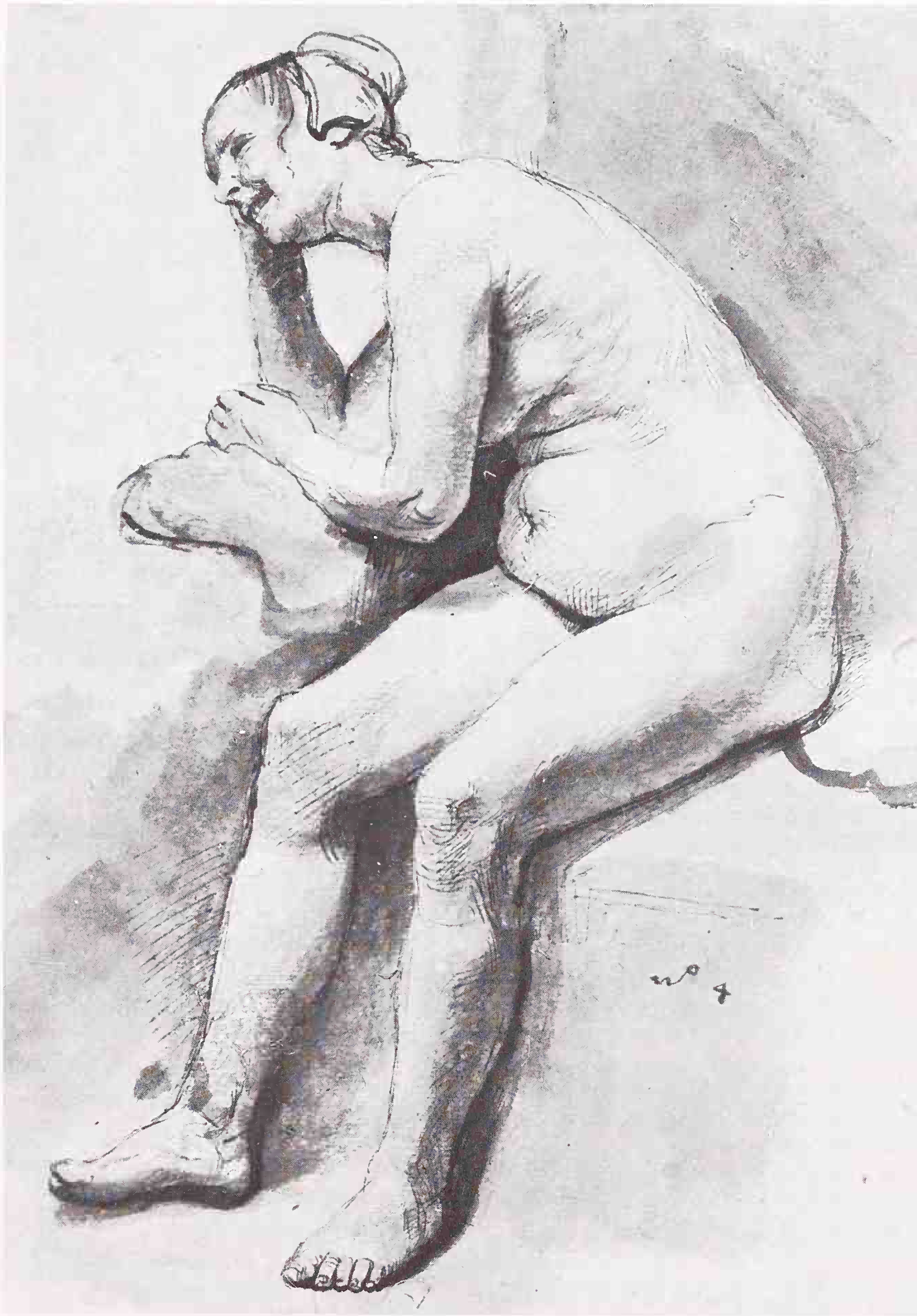
Studies of the Knee by Michelangelo. (Teylers Stichting, Haarlem.)

The blocklike volume of the femur and the tibia as well as the patella and its ligament have been carefully studied by the artist.

7-29

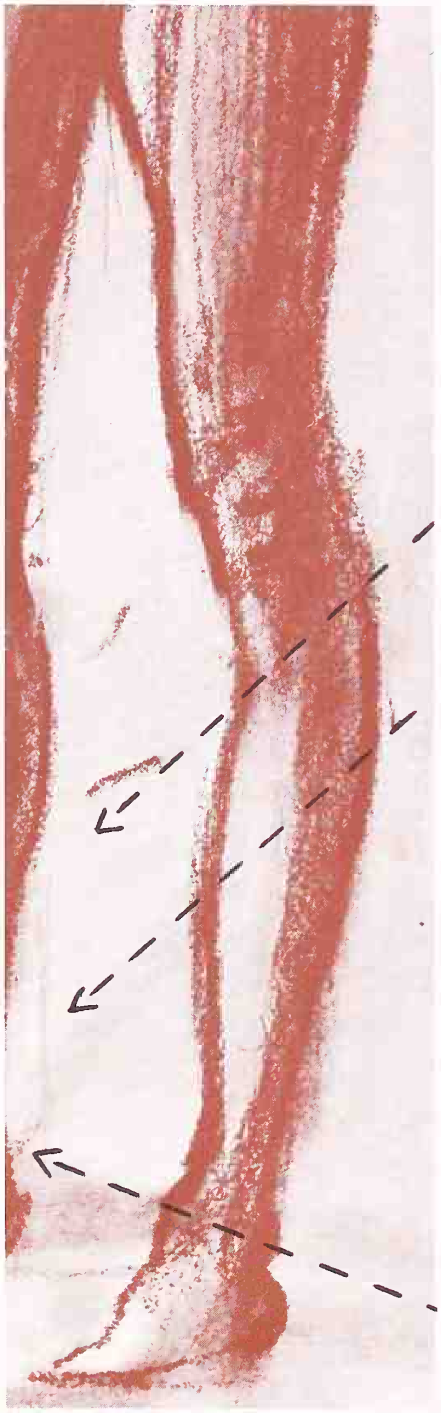
Seated Nude by Rembrandt van Rijin. (Cabinet des Dessins, Musée du Louvre.)

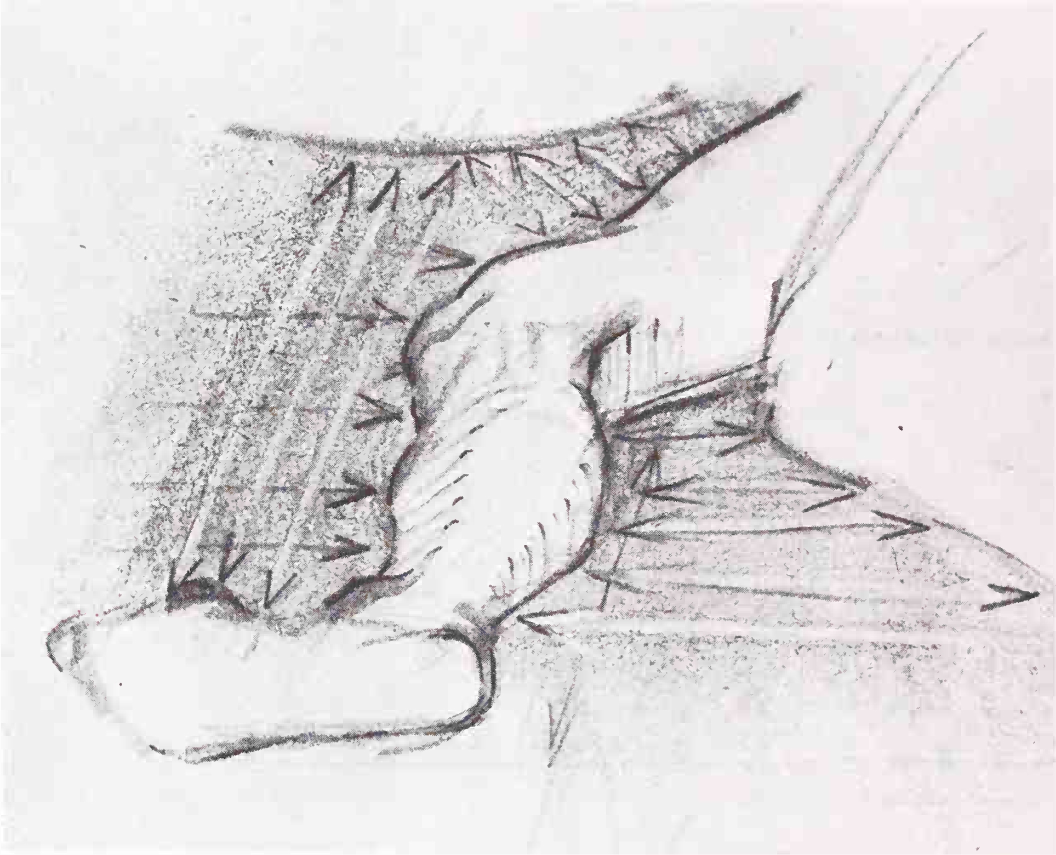
In the leg, when bent, the large bone relationships at the knee set the frame of space for the full volume of the thigh and lower leg. Locations at the top of the kneecap and just behind it establish the origin of the top horizontal light plane moving to its insertion at the hip.



7-29

7-30





7-31

The most characteristic forms in the calf are the two parts of the gastrocnemius muscle (filled out and supported by the flat, elliptical soleus muscle visible beneath) [7-32]. The outer portion of the calf is higher; the inner unit, somewhat lower. This relationship dominates the broad upper form of the lower leg. Both units join the strong, wedgelike Achilles' tendon which attaches to the os calcis bone (heel bone). The thin dimension of this tendon just above the bone should be noted [7-35, 7-36].

The lower leg tapers rapidly to a quite narrow dimension just above the ankle. This is repeatedly ignored as a development and results in a stiff, awkward transition into the ankle. The ankle forms a wider, archlike structure over the foot—the inner ankle higher, the outer ankle lower—a relationship that is the reverse of the two parts of the gastrocnemius. This gives a somewhat shorter appearance to the inner contour of the lower leg (see 7-30).

The remaining muscles of the lower leg, like those in the forearm, are generally slender and numerous [7-32, 7-33]. On the outer front side of the tibia, the dominant muscle is the tibialis anticus which runs parallel with the bone from its outer tuberosity and inserts by a long tendon into the base of the metatarsal of the big toe. Moving back in sequence on the outer side are the long extensor of the toes (extensor digitorum longus) and the peroneus longus (adjoining the soleus). Less evident are the extensor hallucis longus and flexor hallucis longus (both acting on the big toe), the peroneus brevis, and the flexor digitorum longus (deep). All of these muscles should be examined for their exposed tendons and their function [7-26, 7-33].

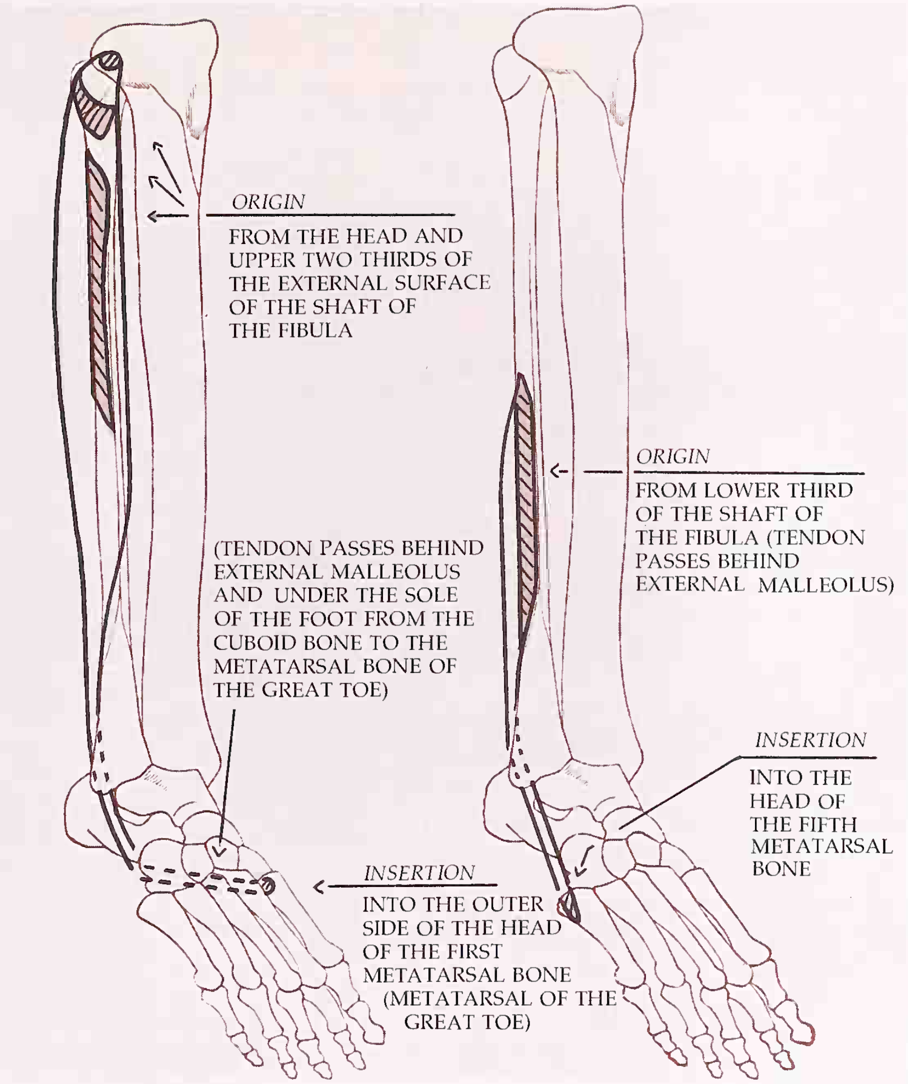
7-30
Study of the Leg by the author. (Photograph by Kalman Zabarsky.)

On the inner side of the leg, the gastrocnemius muscle is lower and the inner ankle is higher than the related prominences on the outer side of this form. This gives a shorter appearance to the inner leg.

7-31
Study of a Leg Foreshortened by the author. (Photograph by Kalman Zabarsky.)

The planes of the foreshortened lower leg are confirmed by the carefully observed space outside the form (indicated by the directional arrows).

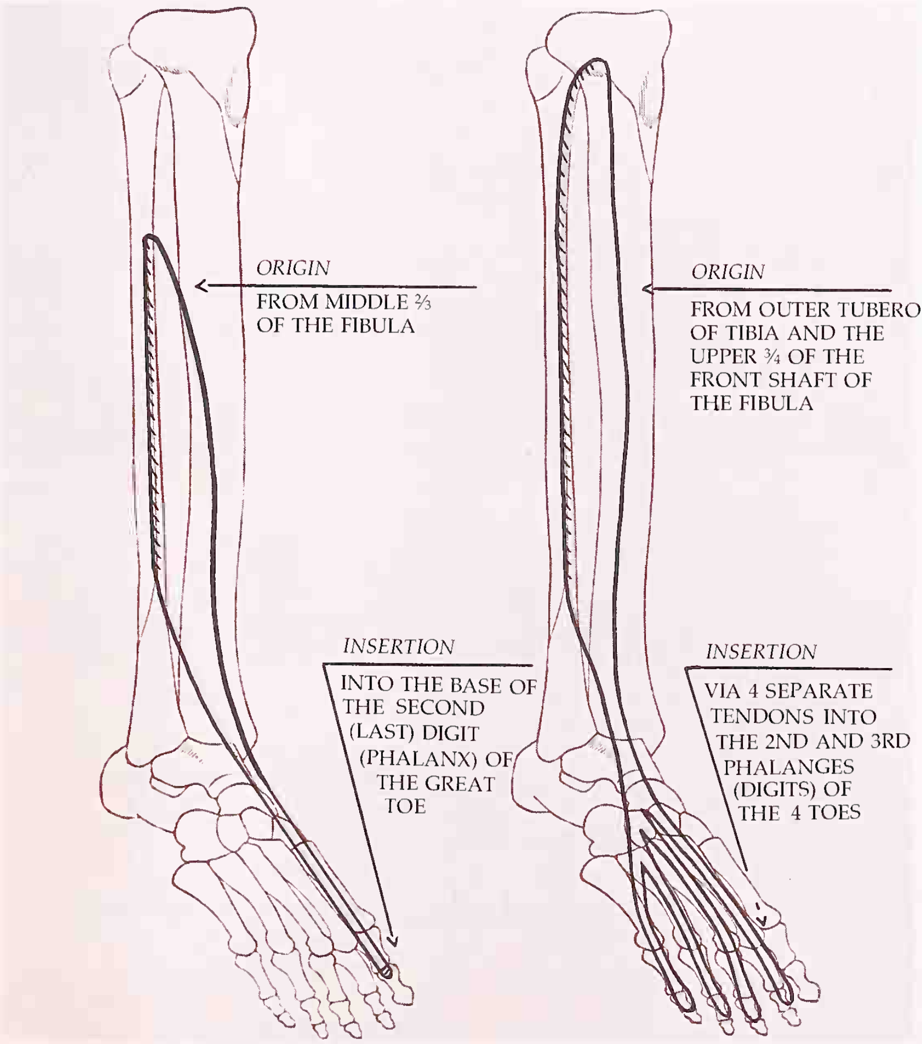
7-33


ORIGIN
FROM THE HEAD AND UPPER TWO THIRDS OF THE EXTERNAL SURFACE OF THE SHAFT OF THE FIBULA
(TENDON PASSES BEHIND EXTERNAL MALLEOLUS AND UNDER THE SOLE OF THE FOOT FROM THE CUBOID BONE TO THE METATARSAL BONE OF THE GREAT TOE)
INSERTION
INTO THE OUTER SIDE OF THE HEAD OF THE FIRST METATARSAL BONE (METATARSAL OF THE GREAT TOE)
ORIGIN
FROM LOWER THIRD OF THE SHAFT OF THE FIBULA (TENDON PASSES BEHIND EXTERNAL MALLEOLUS)
INSERTION
INTO THE HEAD OF THE FIFTH METATARSAL BONE

PERONEUS LONGUS

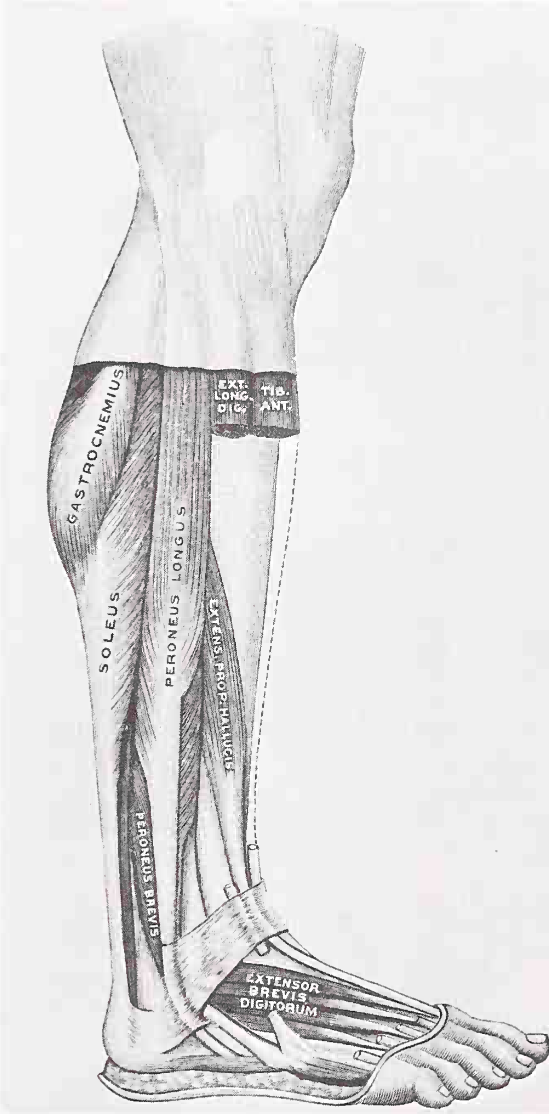
PERONEUS BREVIS

7-34


ORIGIN
FROM MIDDLE ⅔ OF THE FIBULA
INSERTION
INTO THE BASE OF THE SECOND (LAST) DIGIT (PHALANX) OF THE GREAT TOE
ORIGIN
FROM OUTER TUBEROSITY OF TIBIA AND THE UPPER ¾ OF THE FRONT SHAFT OF THE FIBULA
INSERTION
VIA 4 SEPARATE TENDONS INTO THE 2ND AND 3RD PHALANGES (DIGITS) OF THE 4 TOES

EXTENSOR PROPRIUS HALLUCIS
(EXTENSOR DIGITORUM LONGUS)

EXTENSOR LONGUS DIGITORUM
(EXTENSOR HALLUCIS LONGUS)


GASTROCNEMIUS
EXT. LONG. DIG.
TIB. ANT.
SOLEUS
PERONEUS LONGUS
EXTENS. PROP. HALLUCIS
PERONEUS BREVIS
EXTENSOR BREVIS DIGITORUM

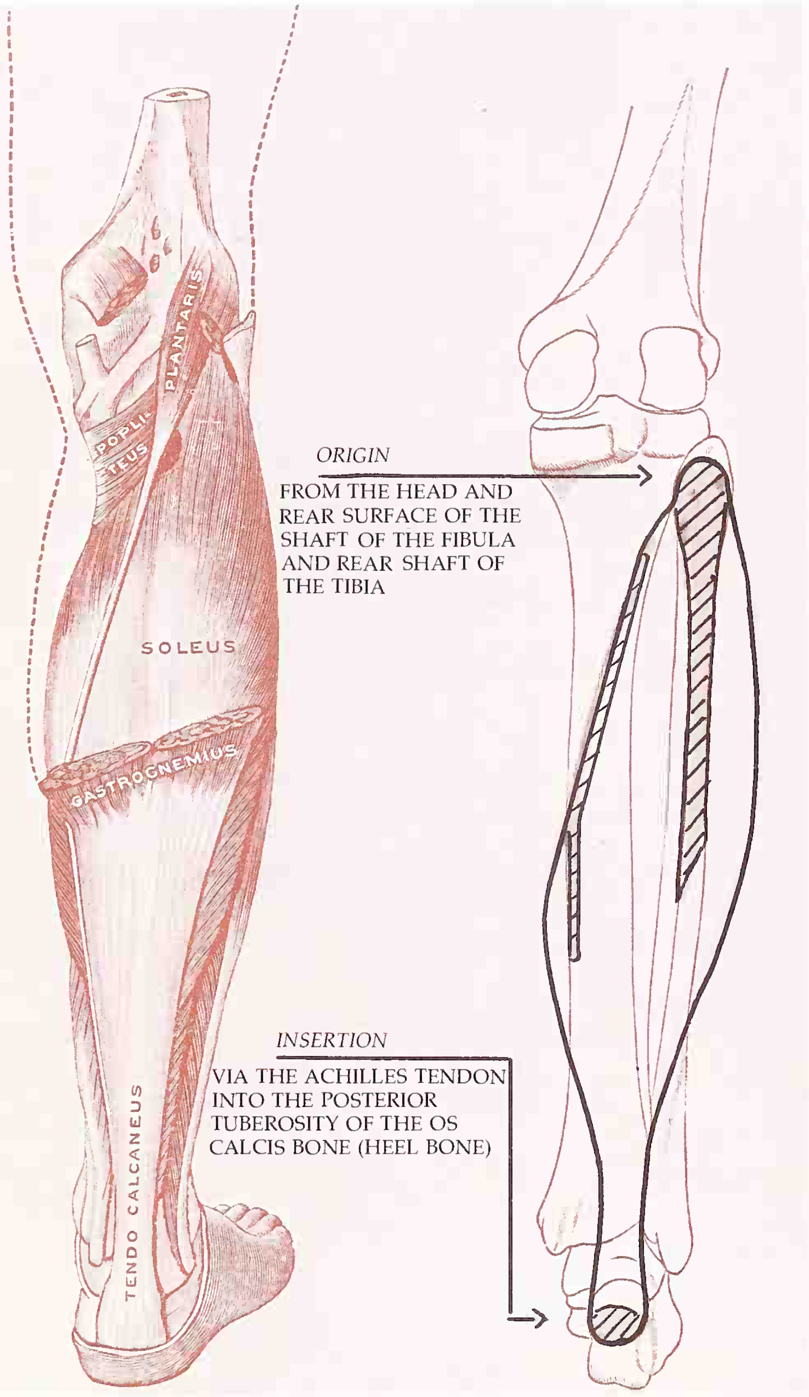
7-32
Muscles of the Right Leg: Outer Side, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

7-33
Peroneus Longus and Peroneus Brevis.

The peroneus longus extends and everts the foot and flexes the heel. The peroneus brevis extends the foot.

7-34
Extensor Proprius Hallucis and Extensor Longus Digitorum.

The extensor proprius hallucis extends the toe. Most of this muscle lies beneath the tibialis anticus and the extensor longus digitorum. Its long, strong tendon is clearly evident on the high inner side of the foot. The extensor longus digitorum also extends the toes.


PLANTARIS
POPLITEUS
SOLEUS
GASTROCNEMIUS
TENDO CALCANEUS

ORIGIN

FROM THE HEAD AND REAR SURFACE OF THE SHAFT OF THE FIBULA AND REAR SHAFT OF THE TIBIA

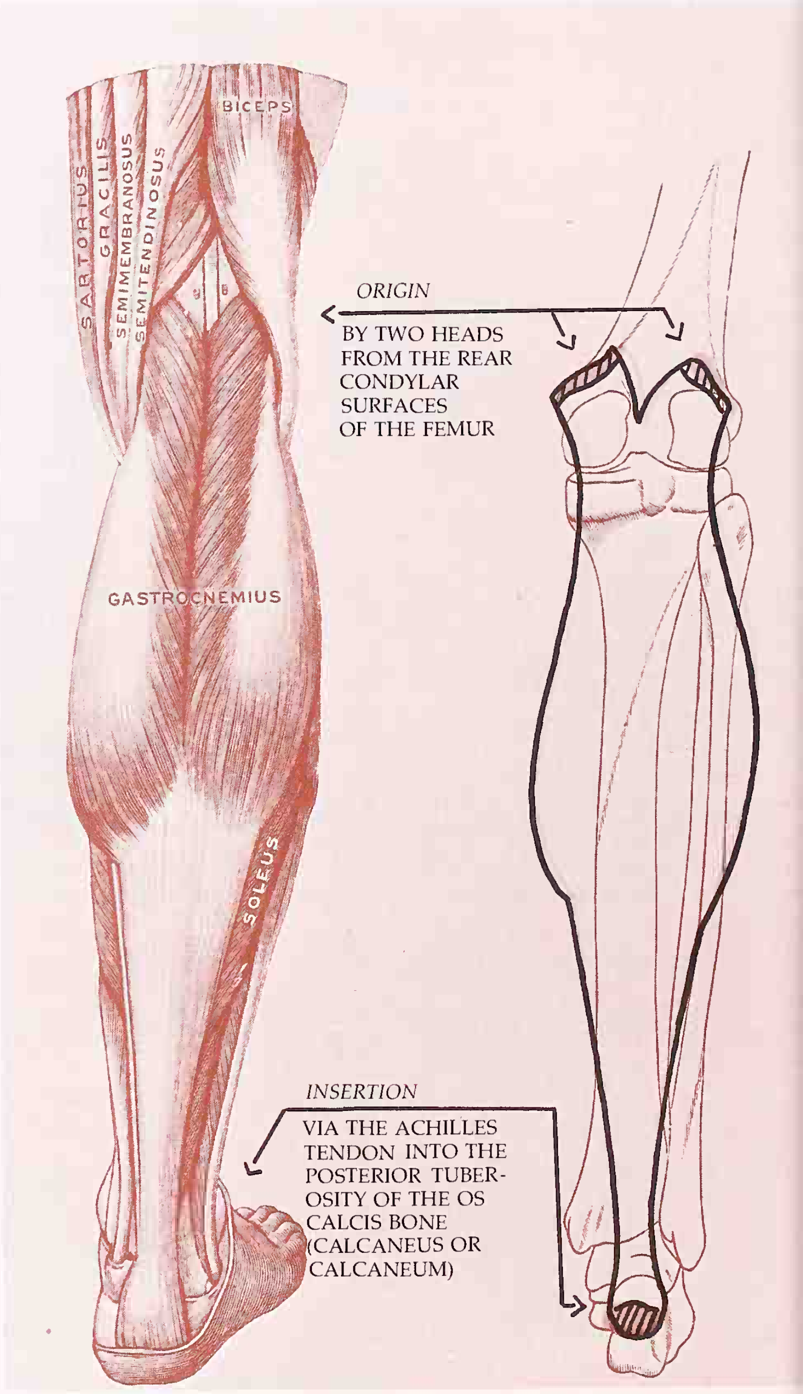
INSERTION

VIA THE ACHILLES TENDON INTO THE POSTERIOR TUBEROSITY OF THE OS CALCIS BONE (HEEL BONE)

SOLEUS AND PLANTARIS

SOLEUS

7-35


SARTORIUS
GRACILIS
SEMIMEMBRANOSUS
SEMITENDINOSUS
BICEPS
GASTROCNEMIUS
SOLEUS

ORIGIN

BY TWO HEADS FROM THE REAR CONDYLAR SURFACES OF THE FEMUR

INSERTION

VIA THE ACHILLES TENDON INTO THE POSTERIOR TUBEROSITY OF THE OS CALCIS BONE (CALCANEUS OR CALCANEUM)

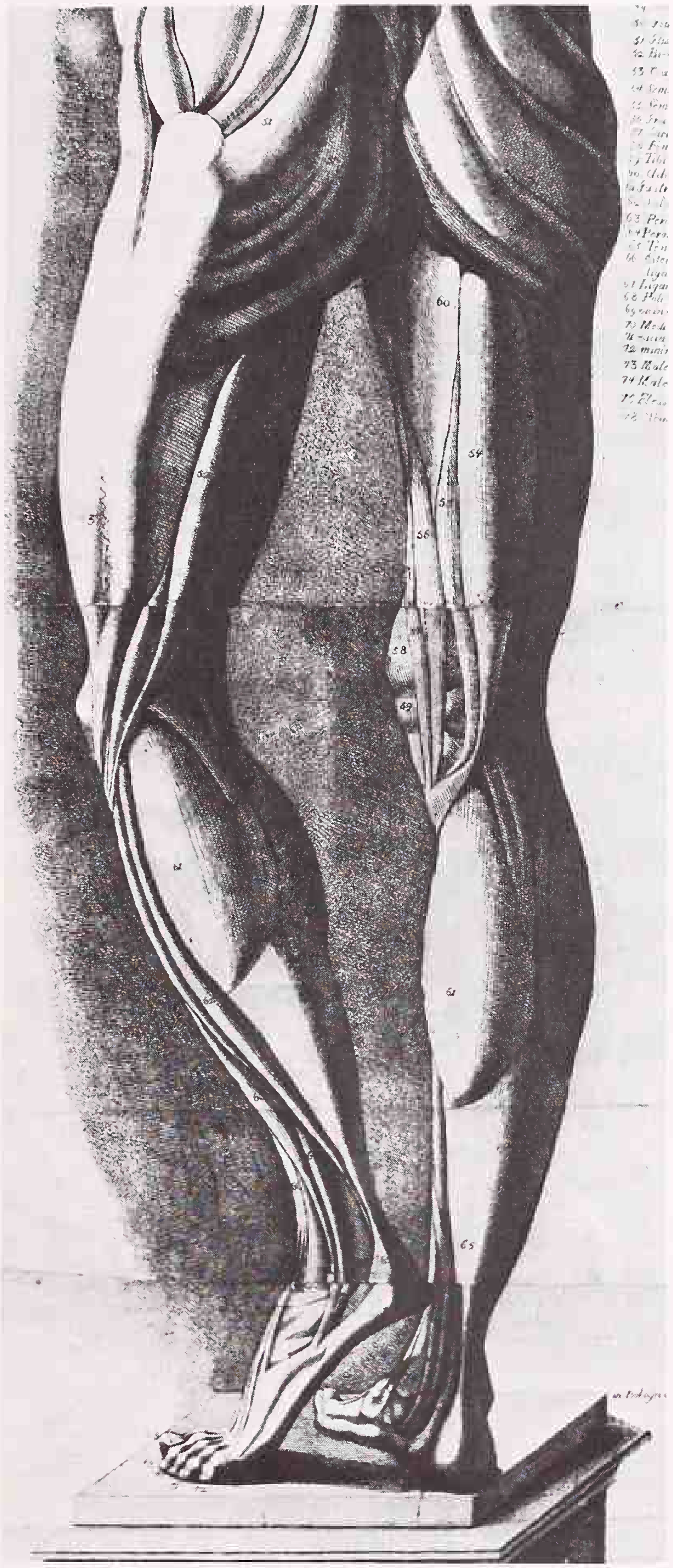
7-36

7-35
Soleus, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

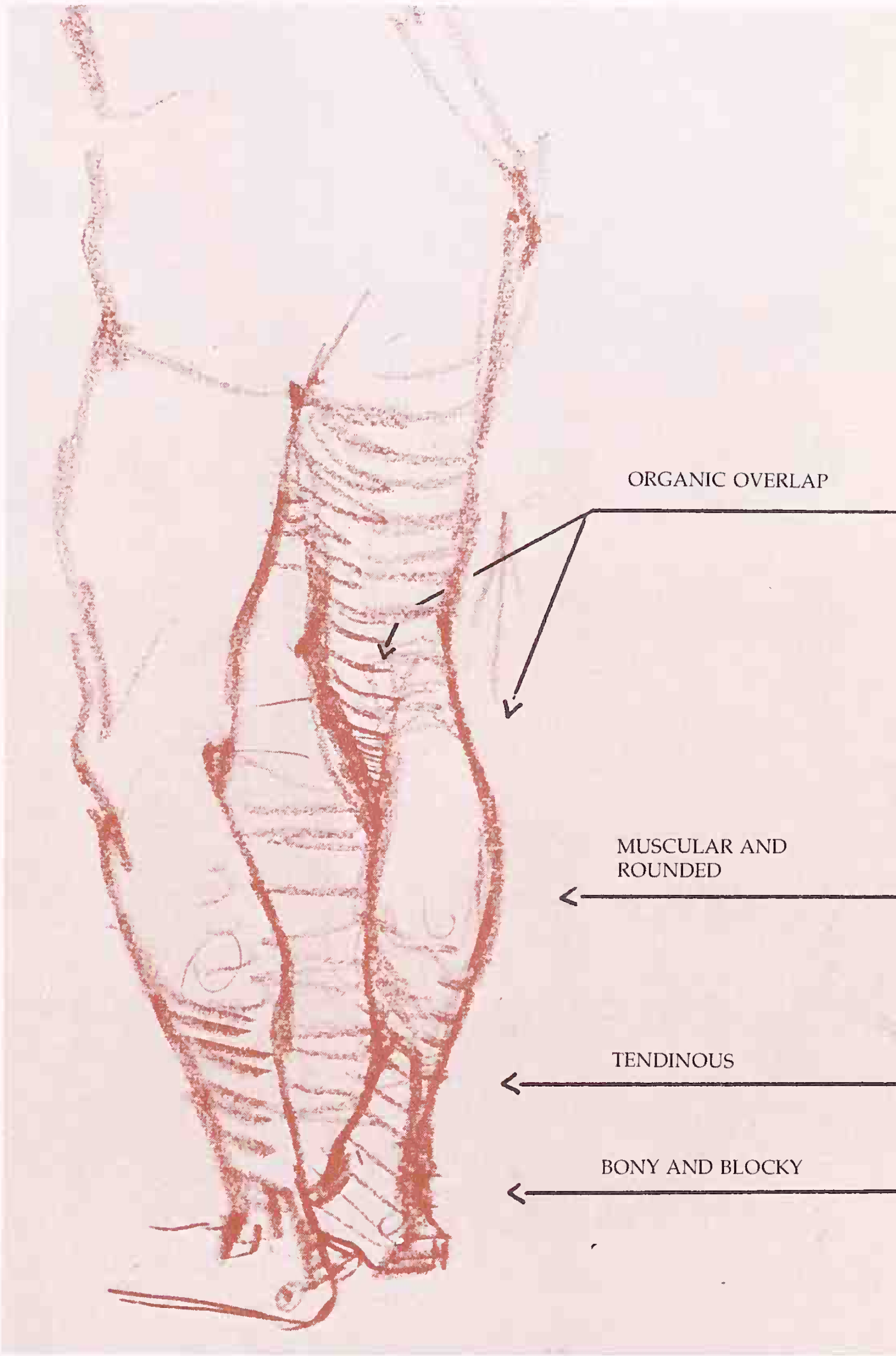
The action of the soleus is to extend the foot.

7-36
Gastrocnemius, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

The gastrocnemius extends the foot.



7-37



7-38

7-37
Detail from Muscles of the Back, from Muscles of the Human Body by Hercules Lelli, engraved on copper by Antonio Cattani. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

The wedgelike structure of the Achilles' tendon and its thin, stringlike dimensions just above the heel bone (os calis) will help to emphasize the tension to which this tendon is continually exposed.

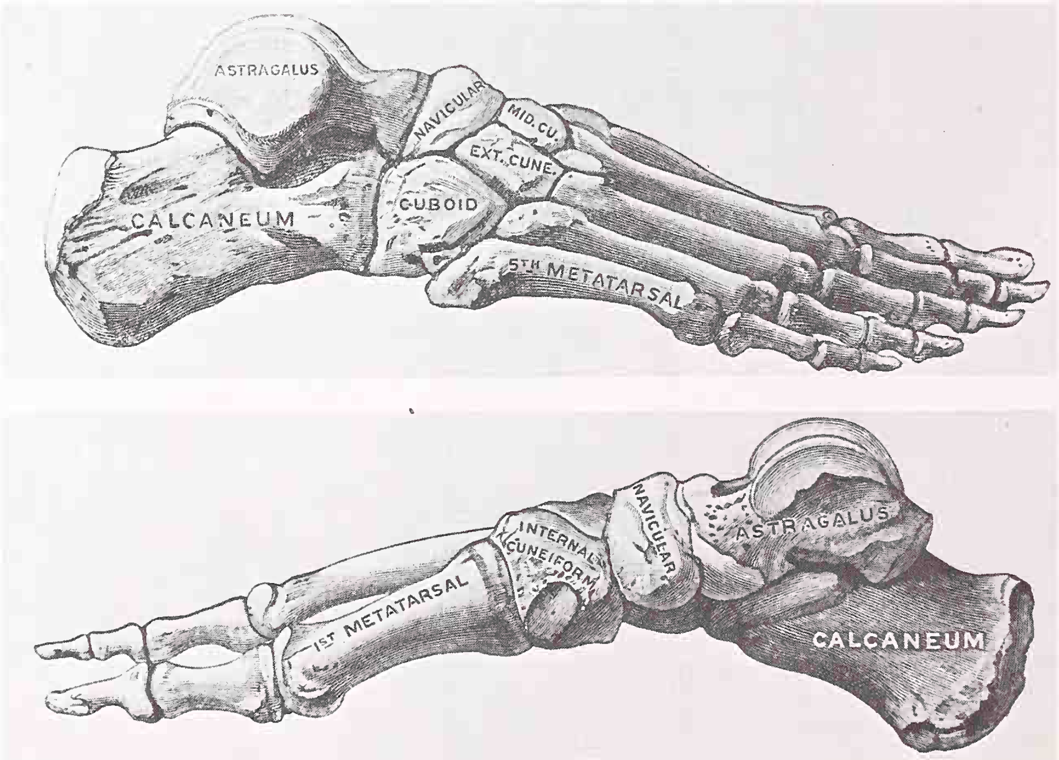
7-38
Study of the Legs: Back View by the author. (Photograph by Iso Papo.)

This brief leg study displays the organic interconnection of big form units (at the knee articulation). The influence of bone and muscles on surface form is distinct and different. Muscular form is rounded and fluid. Bony surface form is angular and blocky.

THE FOOT

The tarsus, forming the arch and heel of the foot, is composed of seven bones. Two, the astragalus and the os calcis, deserve special comment. The thick, archlike upper segment of the astragalus (talus) articulates with the underside of the tibia bone. The lower portion of the astragalus fits snugly into the saddle-shaped depression of the os calcis. The full weight of the figure is transmitted to these two rugged bones. Ample thrust, behind the ankles, should be given to the blocklike os calcis. The five remaining tarsus bones form the high portion of the arch of the foot [7-39].

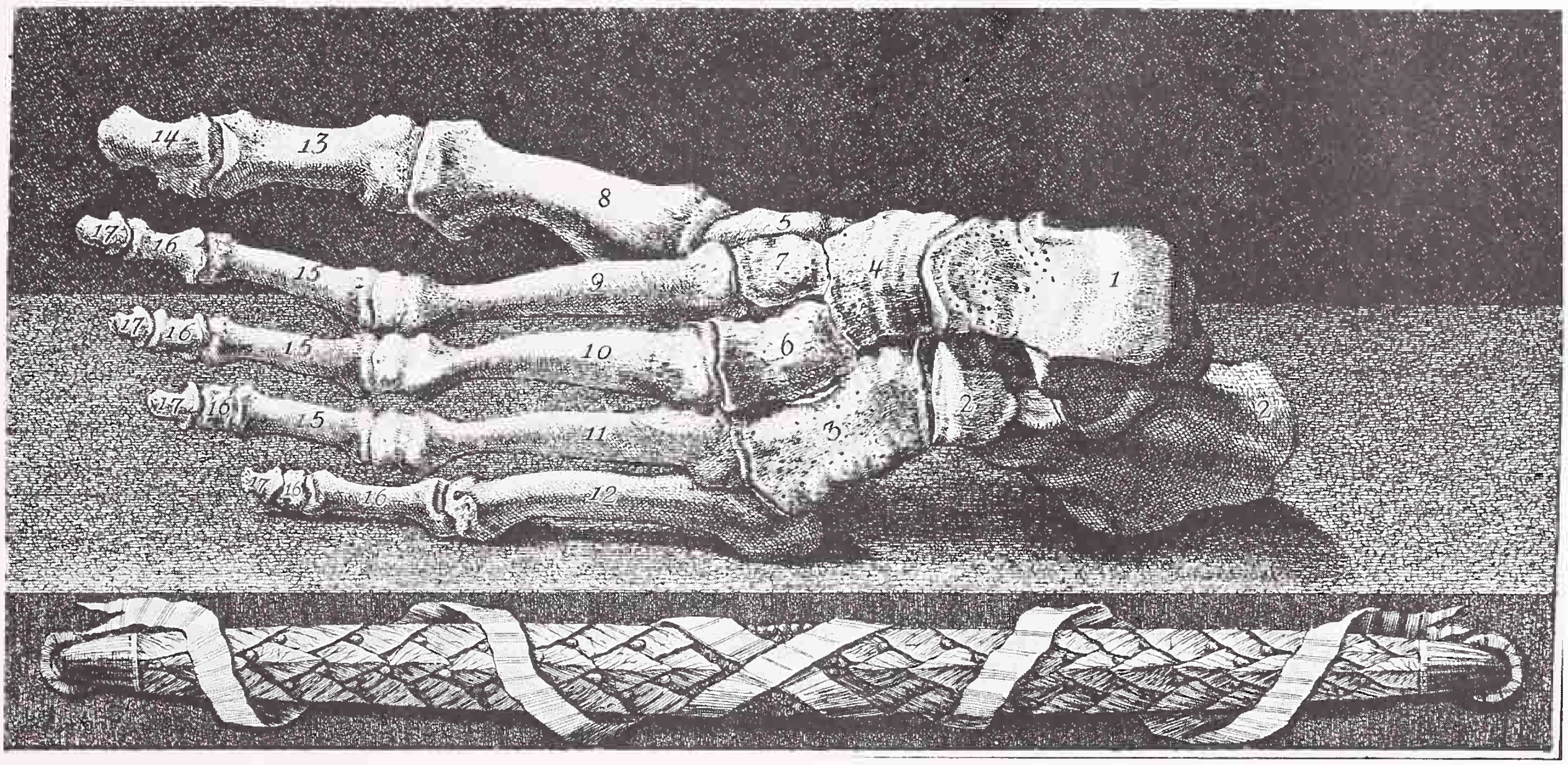
The five long metatarsals flare diagonally forward into the phalangeal units of the toes [7-40, 7-41, 7-44]. The arched form of the foot is highest along a ridgelike axis extending into the big toe [7-42]. Below the ankle, the inner side plane of the foot is vertical [7-39]. The top plane fans out from the ankle diagonally down and forward, flattening just behind the toes. The toes, as a group, are often mistakenly drawn at rigid right angle to the length of the foot; in fact, they form a wedgelike projection toward the big toe.


ASTRAGALUS
NAVICULAR
MID. CU.
EXT. CUNE.
CUBOID
CALCANEUM
5TH METATARSAL
NAVICULAR
INTERNAL CUNEIFORM
ASTRAGALUS
1ST METATARSAL
CALCANEUM

7-39

7-39
The Bones of the Right Foot: from the Outer Side (top) and the Bones of the Right Foot: from the Inner Side (bottom), from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

7-40



7-40

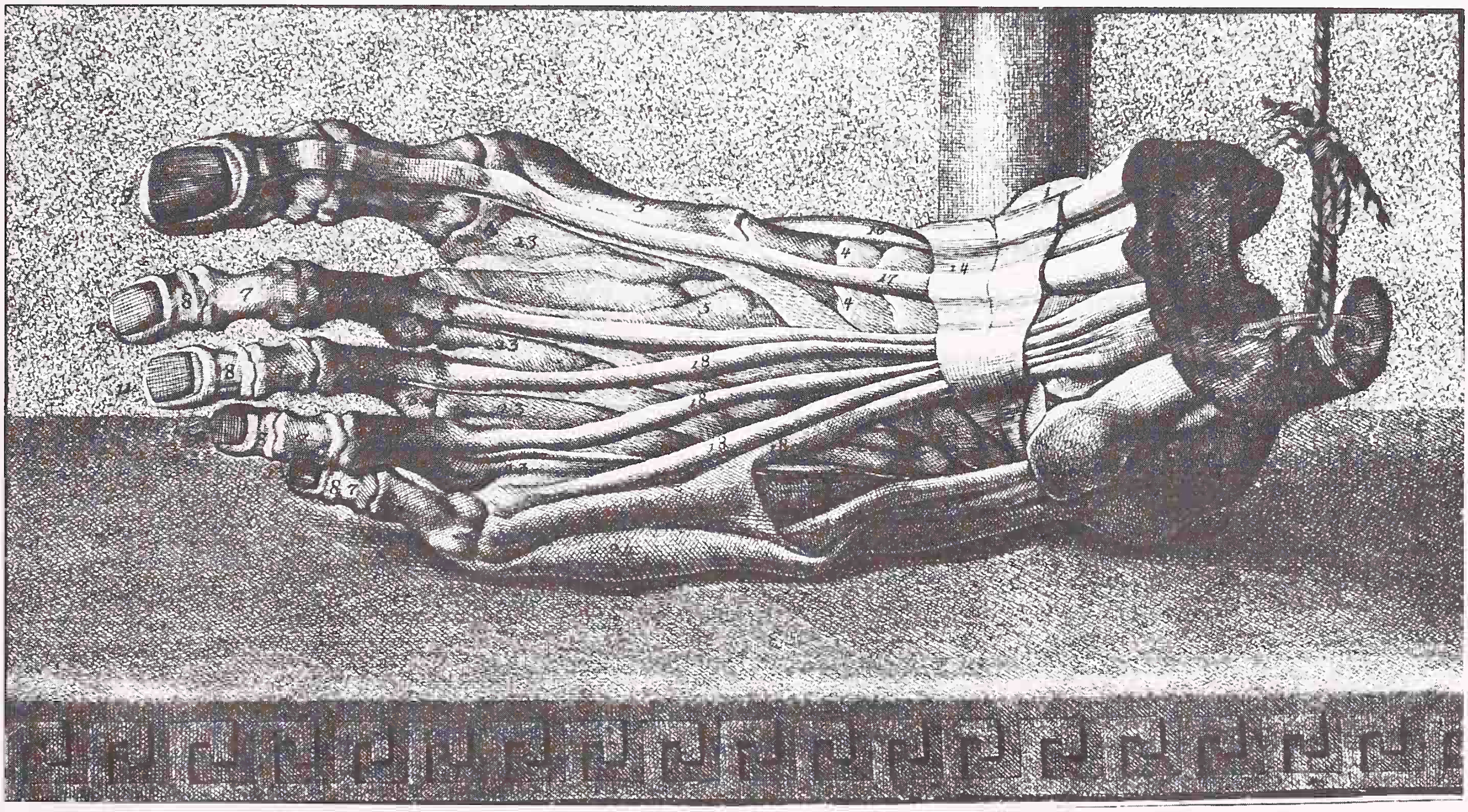
Bones of the Foot, from Twenty Plates of the Osteology and Myology of the Hand, Foot, and Head by Antonio Cattani. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Jonathan Goell.)

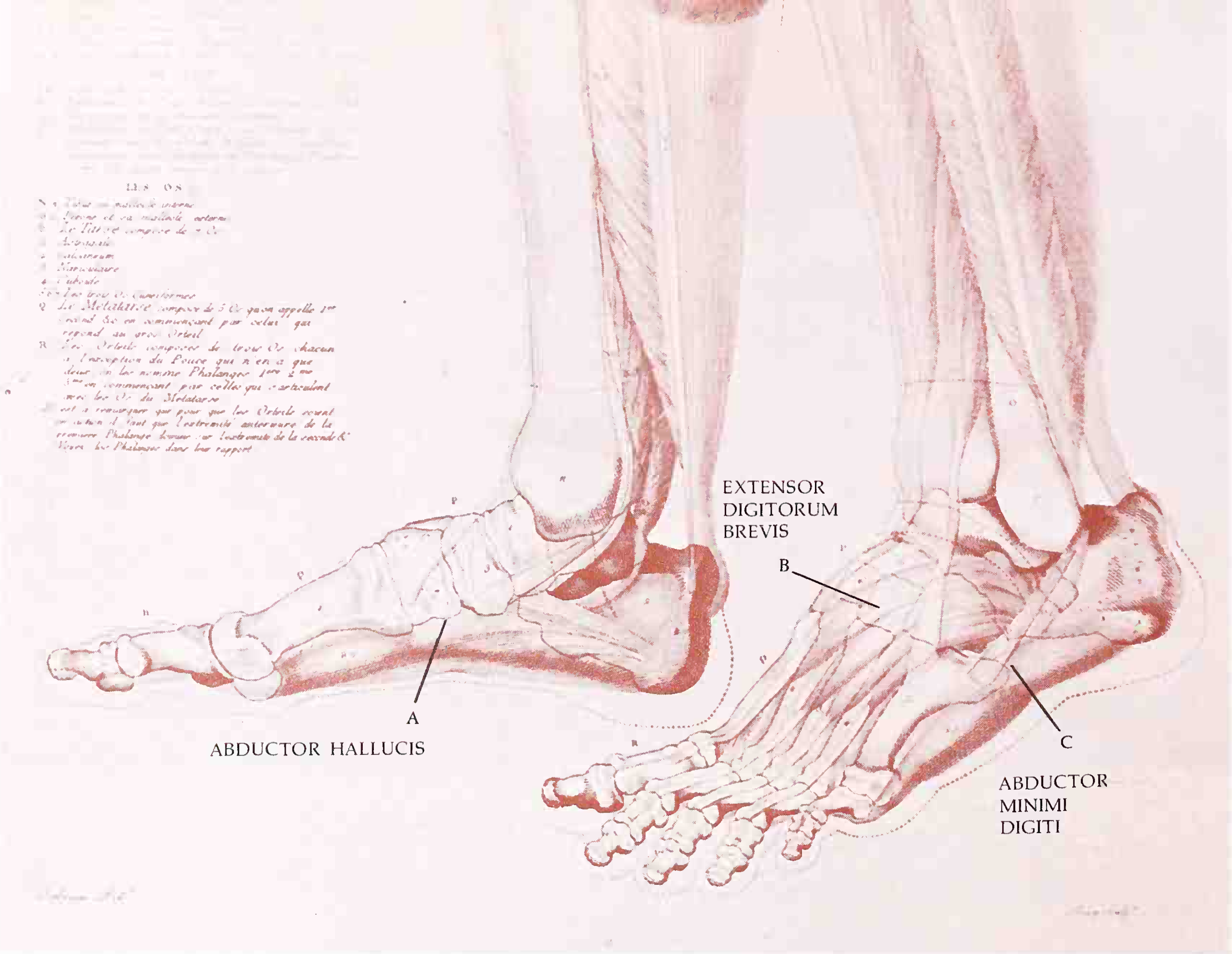
The tarsus forms the arch and the heel of the foot and is composed of the following bones; astragalus *(1)*; os calcis (heel bone) *(2)*; cuboid *(3)*; scaphoid (navicular) *(4)*; internal cuneiform *(5)*; external cuneiform *(6)*; middle cuneiform *(7)*. The metatarsals *(8, 9, 10, 11, 12)* flare into the phalanges *(13, 14, 15, 16, 17)*. Compare this illustration with the drawings of the foot by Leonardo [4-6].

7-41

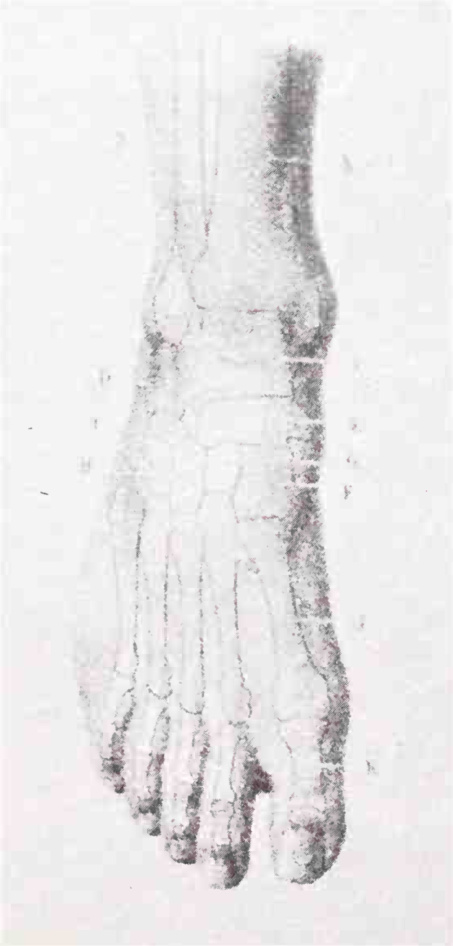
Bones of the Foot, from Twenty Plates of the Osteology and Myology of the Hand, Foot, and Head by Antonio Cattani. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Jonathan Goell.)

7-41





7-42



7-43

Like the hand, the foot is bony and tendinous on top and thickly padded below. The thin, flat extensor digitorum brevis muscle, from its origin on the outer side of the os calcis bone, fans out into four heads over the metatarsals and inserts into the phalanges of the toes (except the little toe). It extends the toes. This muscle does not hide the bony structure of the metatarsals [7-42].

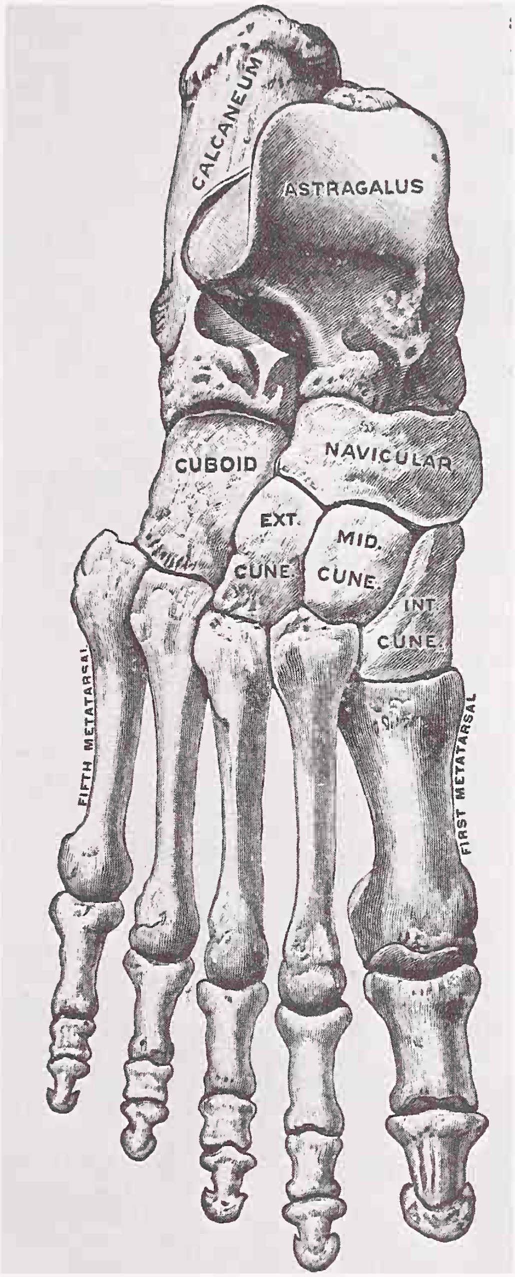
The muscles underneath the foot are heavily padded with thickened skin at the heel and ball (beneath the first phalangeal articulation) and emphasize its archlike structure.

7-42
Bones and Muscles of the Foot, from Anatomy of Bones and Muscles Applicable to the Fine Arts by Jean Galbert Salvage. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

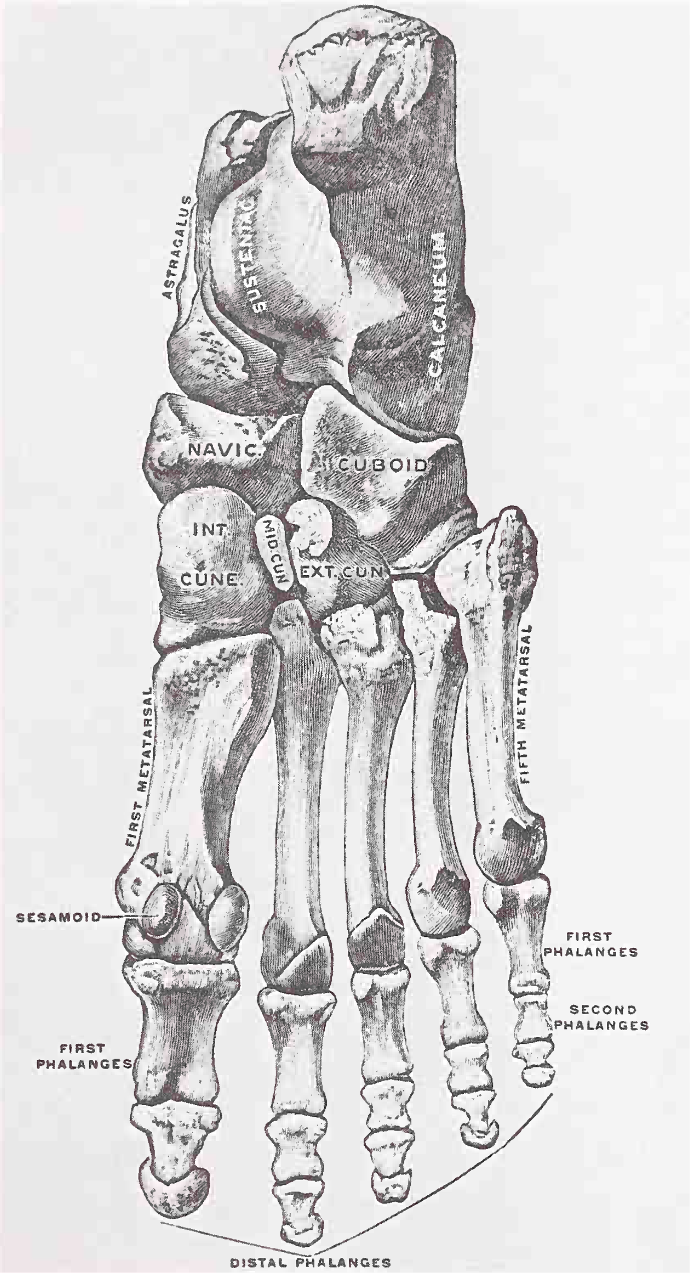
In this side view, three of the major muscles of the foot are seen. They are: abductor hallucis *(A)*; extensor digitorum brevis *(B)*; abductor minimi digiti *(C)*. Compare the abductor hallucis here with its articulation in the drawing by Michelangelo [7-12].

7-43
The Foot, from Anatomie of the External Forms of Man by Julian Fau. (Courtesy: Boston Medical Library in the Francis A. Countway Library of Medicine. Photograph by Kalman Zabarsky.)

In this top view of the foot, the bones of the ankle and the foot may be seen, as well as their influence on the contour. Compare this with the two studies of the bones of the foot by Leonardo [6-5].


CALCANEUM
ASTRAGALUS
CUBOID
NAVICULAR
EXT.
CUNE.
MID.
CUNE.
INT.
CUNE.
FIFTH METATARSAL
FIRST METATARSAL

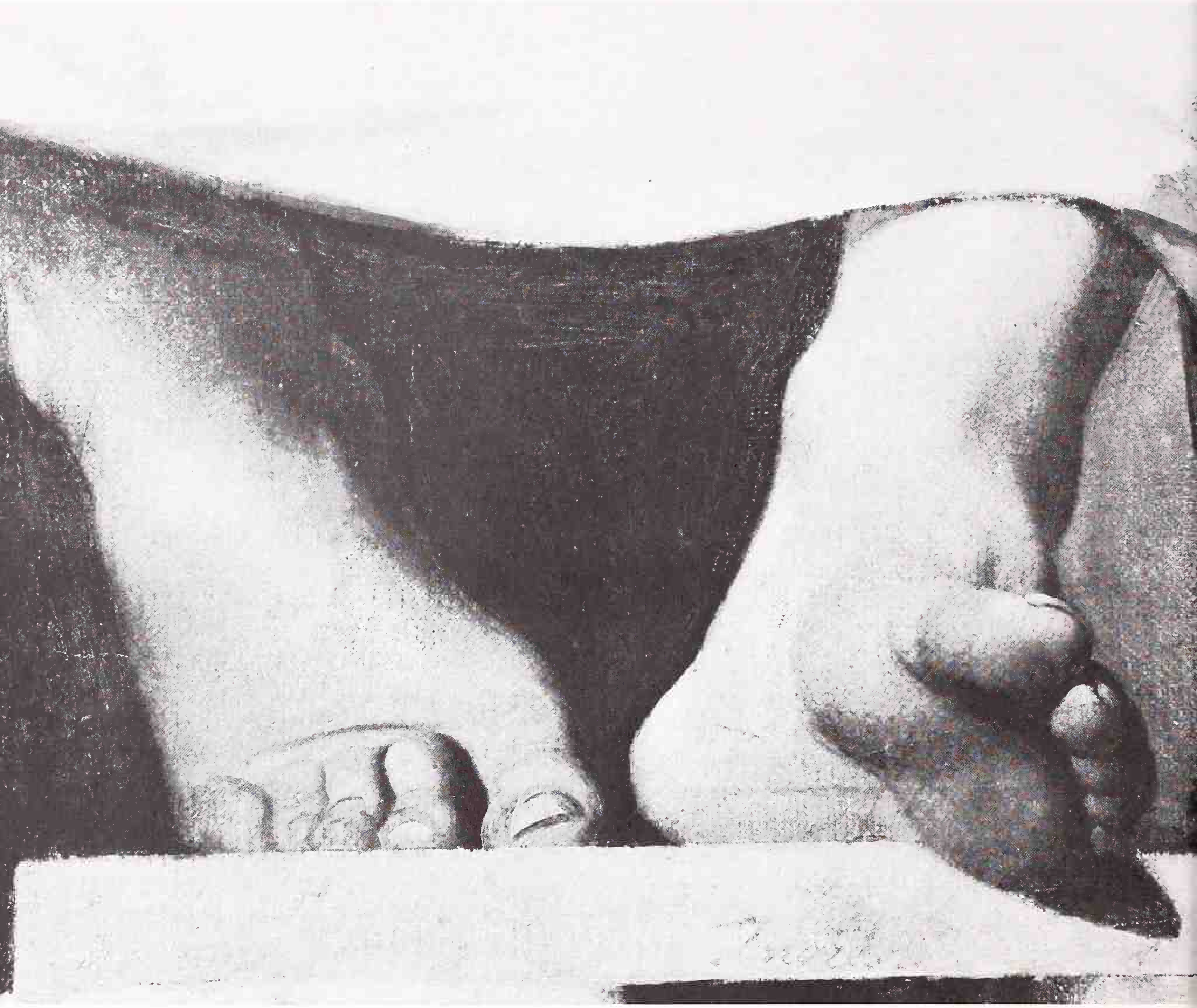
7-44


ASTRAGALUS
SUSTENTAC.
CALCANEUM
NAVIC.
CUBOID
INT.
CUNE.
MID CUN.
EXT. CUN.
FIRST METATARSAL
FIFTH METATARSAL
SESAMOID
FIRST PHALANGES
SECOND PHALANGES
FIRST PHALANGES
DISTAL PHALANGES

7-45

7-44
The Bones of the Right Foot: from Above, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)

7-45
The Bones of the Right Foot from Below, from Traité D'Anatomie Humaine by Jean Leo Testut. (Photograph by Iso Papo.)



7-46

7-46
Study for the Feet of Homer, from Homère Déifié by Jean Dominique Ingres. (Musée du Louvre.)
Compare the height of the inner ankle and the arch of the foot to the position of the heel in a foreshortened view.

Study Assignment

The Lower Extremity and Muscles of the Leg

Femur: study ball-and-socket articulation in acetabulum.
Draw patella, tibia, and femur (knee articulation) and fibula-tibia (ankle articulation).
Draw two views of foot reflected in a mirror.
Draw legs from the model or your leg in a mirror.
Read chapter.
Draw the extensor, adductor, and flexor muscles of the leg.

Alternate Exercise

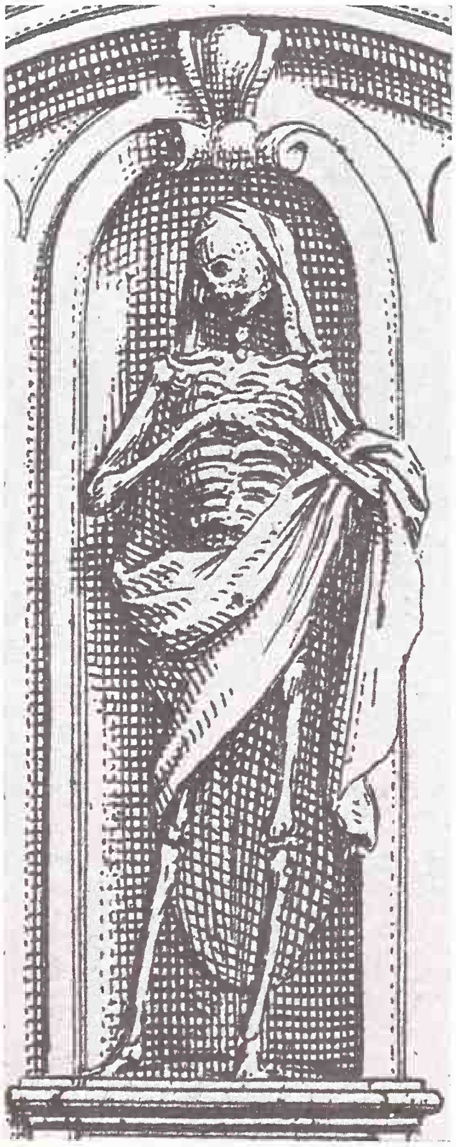
Over a drawing of the bones of leg and foot, place a sheet of tracing vellum. Draw the muscles of the leg, indicating the origin and the insertion of each muscle.

CHAPTER 8

DRAPE FORMATION ON THE COSTUMED FIGURE

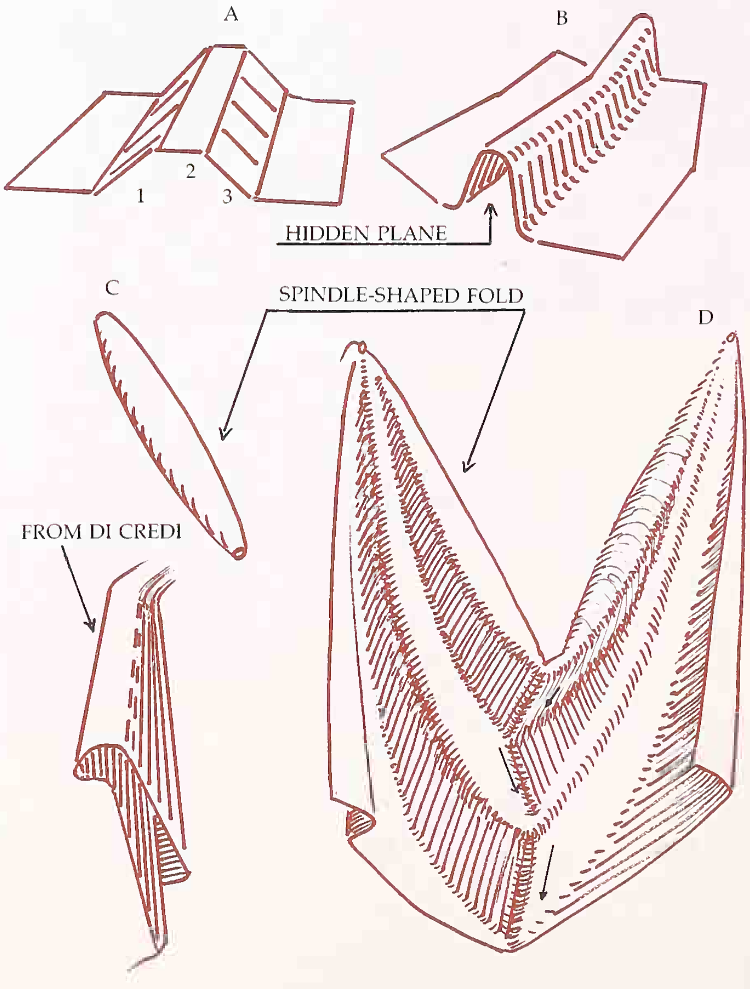
The disposition of drapery on the costumed figure is susceptible to numerous combinations. Each body stance and gesture will alter the complexity of folds on the human form, often to the bewilderment of the inexperienced draftsman. This apparent disorder, copied without discernment, will create a chaos of accidental effect and inconsistent space.

Since drapery is modified by the form it covers, the influence of anatomic structure cannot be ignored. Failure to appreciate the importance of this underlying order will lead to disconnected, broken forms and ultimate disarray in a figure drawing. The causes of this drawing problem stem from a lack of awareness of how skeletal and muscular anatomy influence the origin and order of specific folds; a lack of understanding of how drapery is affected by gravity; and a lack of knowledge of the basic surface structure of an individual fold [8-2, 8-3].

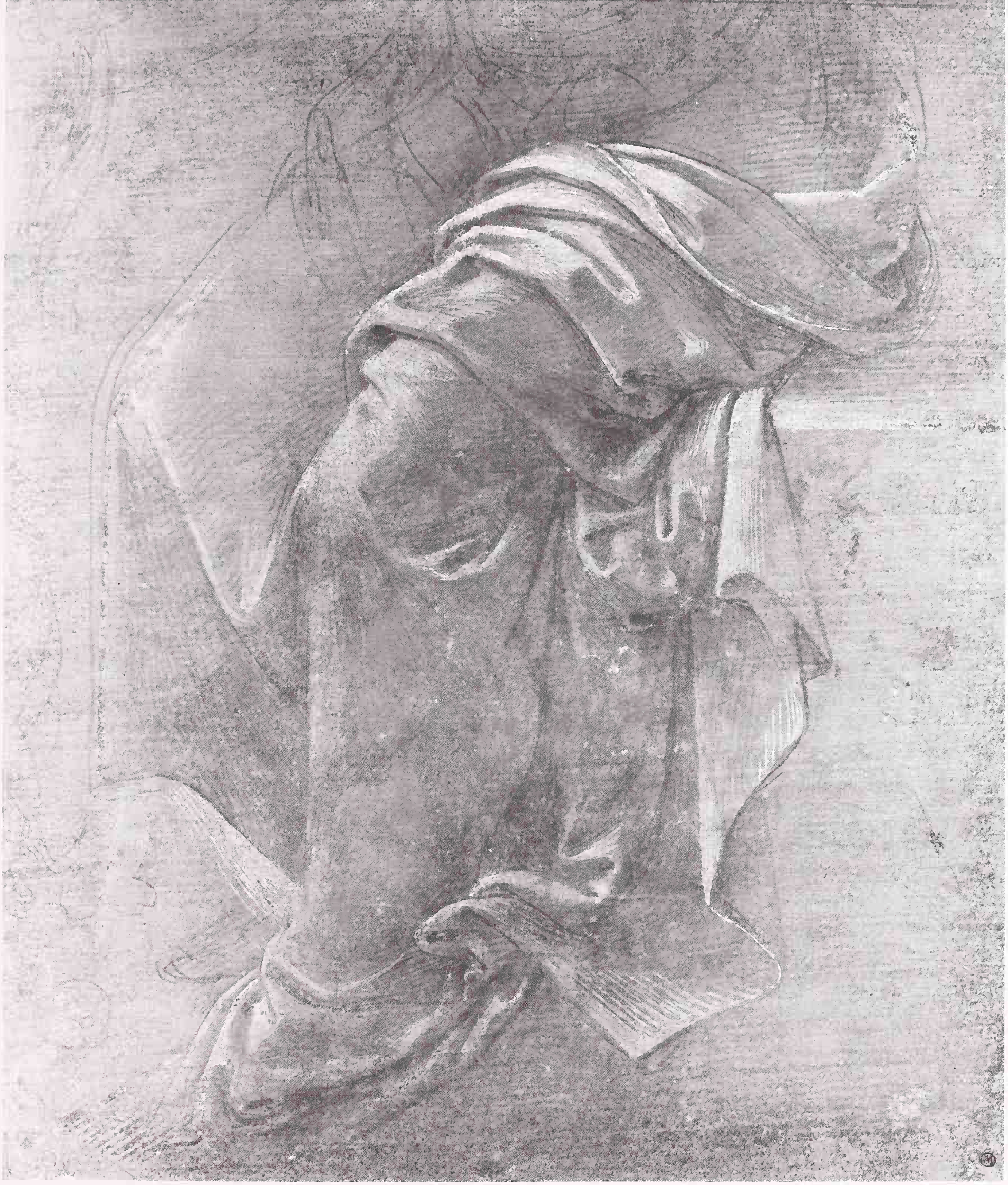


8-1

8-1
Draped Skeleton Detail from an Engraving of an Architectural Facade. (Collection: the author. Photograph by Iso Papo.)



8-2



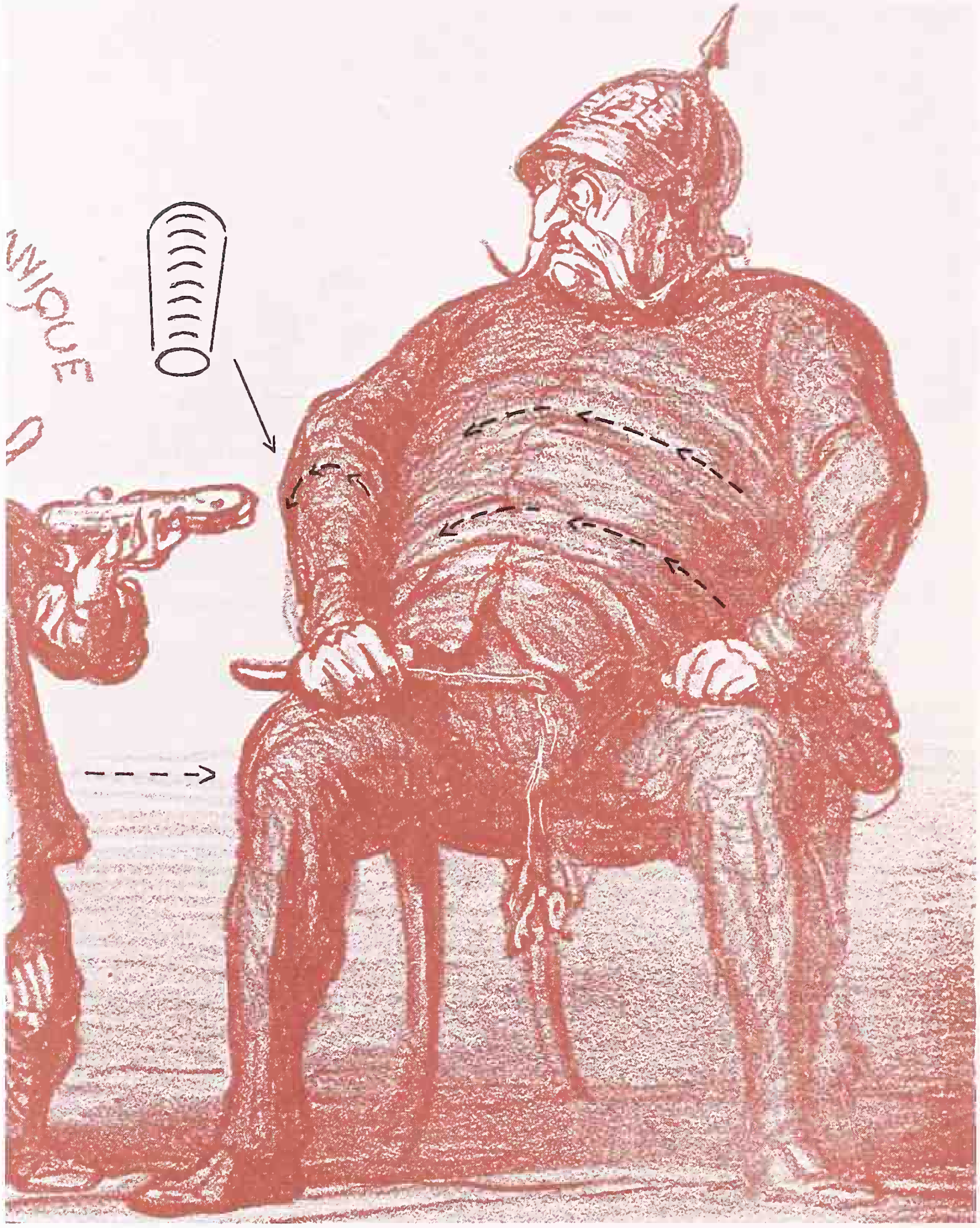
8-3

8-2
The Anatomy of a Fold.

A fold has basically three surfaces (A). Often one surface is hidden (B). A drape suspended from two points will have spindle-shaped folds, pinched at both ends (C). Angular plane changes should be carefully located (arrows, in D) to convey surface direction between related folds.

8-3
Drapery Study from the School of Lorenzo di Credi. (Fogg Art Museum, Harvard University; Bequest of Charles A. Loeser.)

The structure of a single fold. A fold has basically three surfaces. This is well illustrated in the large white fold to the right of the thigh. This artist has described with firm clarity the drapery on the thigh. Two small folds frame the knee. The plane of light is the width of the knee and gradually expands at the hip. The folds on the thigh conform to the volume beneath and preserve its identity.



8-4

8-4

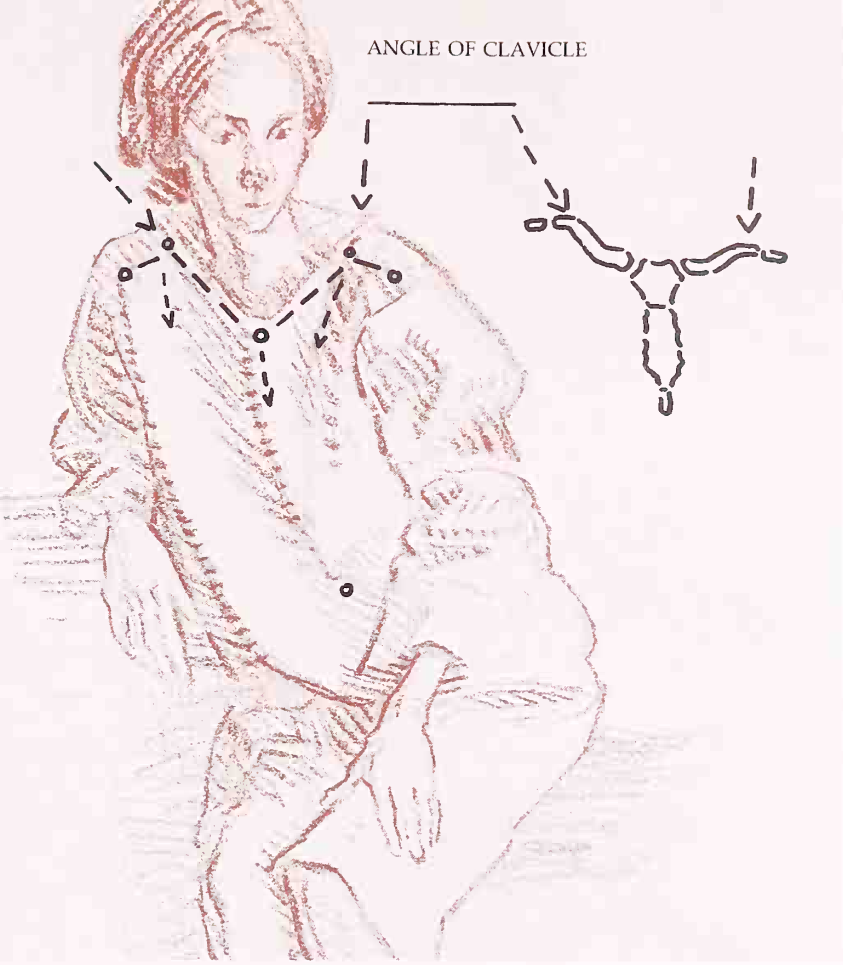
Detail from Prussian with Cat-o-Nine-Tails (lithograph) by Honoré Daumier. (Collection: the author. Photograph by Iso Papo.)

Weight and mass are powerfully reinforced by the vigorous modeling of curving parallel crayon marks following the form from shoulder to hip and forearm. By contrast, the use of repeated firm horizontal crayon lines of the floor plane offers solid support for feet and chair. The conical form of the arm is emphasized by vigorous modeling.

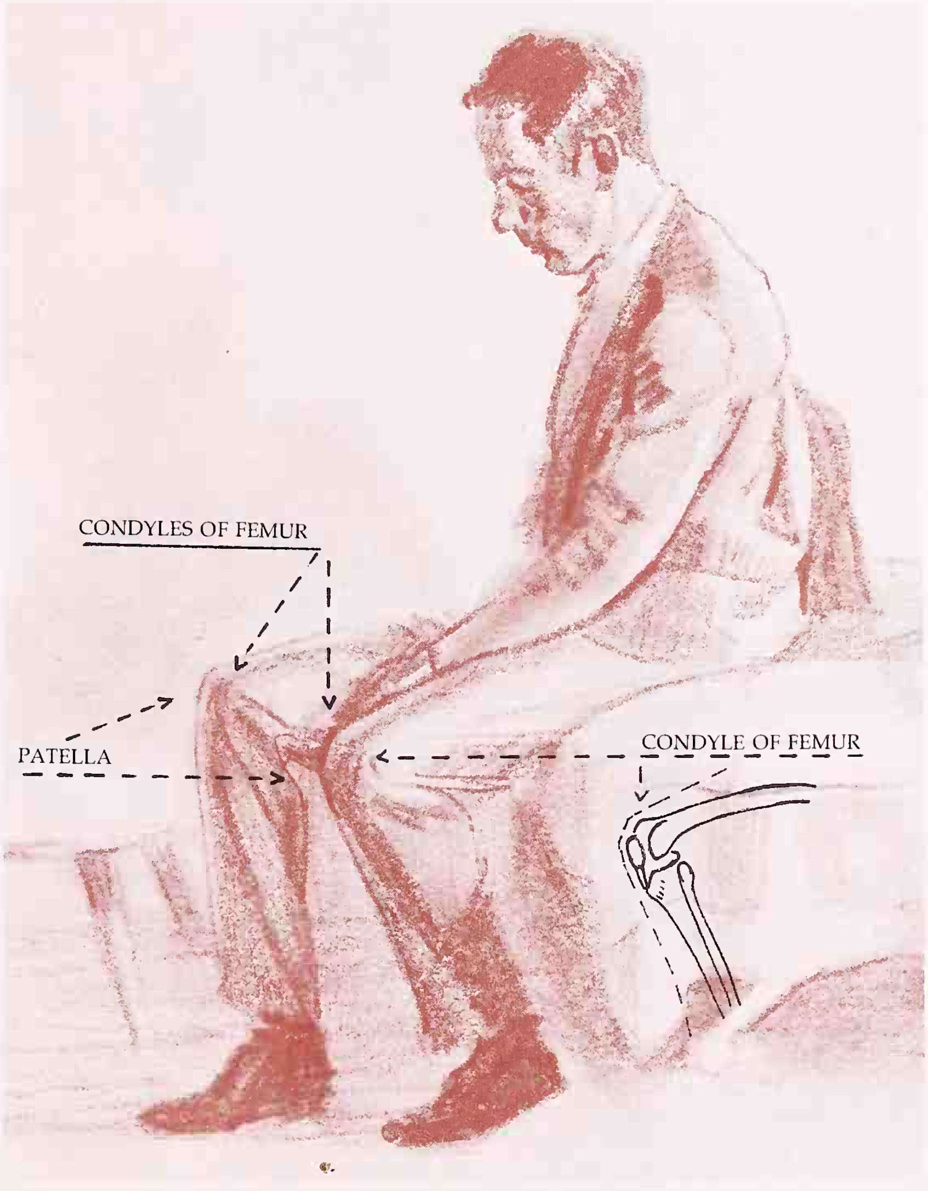
Muscular and skeletal anatomy generate folds in drapery in all parts of the figure. Important folds originate at skeletal articulations where bone is evident and hard, chiseled surfaces prevail. At the collarbone, shoulder blade, elbow, hip, and knee major folds coincide with skeletal architecture [8-3].

Muscle volume also affects broad surface form and folds in the figure. This is particularly noticeable in the upper torso, buttocks, and the roundness of limbs. The continuity of the firm volume of the figure should be clearly distinguished from the loose folds of drapery suspended from it. The treatment of drapery, therefore, soon reveals how well an artist can distinguish substantial underlying structure from surface detail.

Long folds generally "break" from the outer angle of flexed limbs. Obvious examples are the bent elbow or knee. The precise origin of a network of individual folds will frame an articulation. The kneecap (patella), for example, may be confined by a group of folds revealing clearly its triangular shape [8-5, 8-6].



8-5



8-6

8-5

Seated Girl in Dress by the author. (Photograph by Iso Papo.)

The angles of the clavicle (collarbone) establish the relationship of large folds fastened against the clavicle and following the gesture of the torso. The angles at the outer third of both clavicles are the origin for the large V-shaped fold descending over the front of the torso.

8-6

Man Seated on Edge of Bed by the author. (Photograph by Iso Papo.)

The precise identity of the origin of folds is important for conveying the sense of firm form beneath the drapery. Skeletal architecture in the limbs is the point of origin for hanging drapery. Take note of the condyles of the femur and shape of the patella. Folds of drapery are suspended from these points.

8-7
Jefferson by Lloyd Lillie. (Museum of the West, St. Louis, Missouri.)

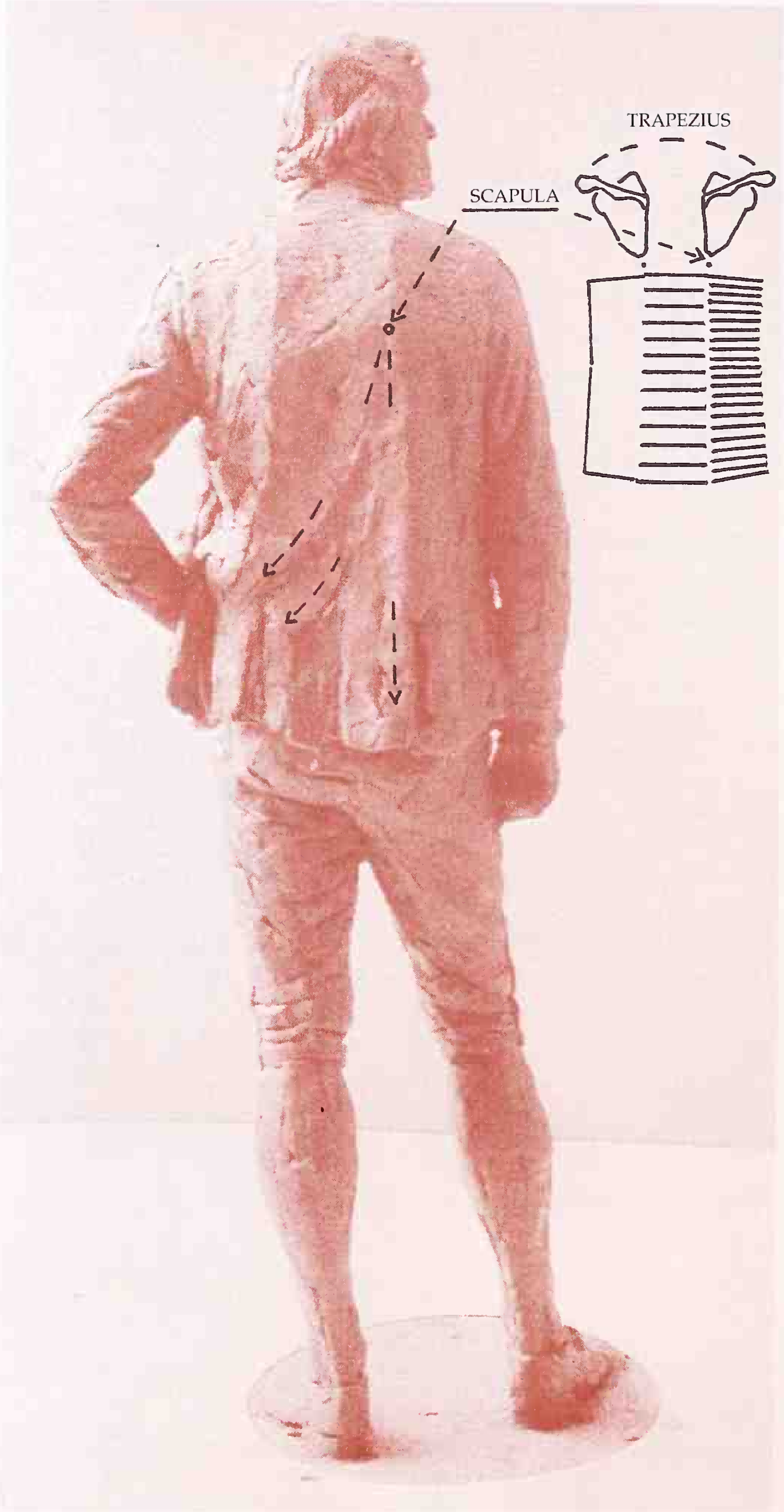
In this study for the figure of Jefferson the vertebral borders of the scapulae are the origin for folds of drapery in the back. The two scapulae create three long planes similar to a three-paneled screen enclosing the torso. The opposing planar relationship of the scapulae is determined at a deeper level by the curvature of the rib cage.

8-8
Liberté by Honoré Daumier. (Collection: the author. Photograph by Iso Papo.)

Planes of the back are clearly identified by the unified shadow on the back. The dark contour and the edge of shadow within the form are essentially parallel and contain and identify the big planes of the back and hip.

8-9
Stripes and Structure: Crouching Girl in Striped Dress by the author. (Photograph by Iso Papo.)

Ribbon-striped costumes provide an easy clue to surface changes in a form. Stripes follow the curvature of the ribs and buttocks. Arrows identify the joining of planes from the scapula to the ribs and buttocks.



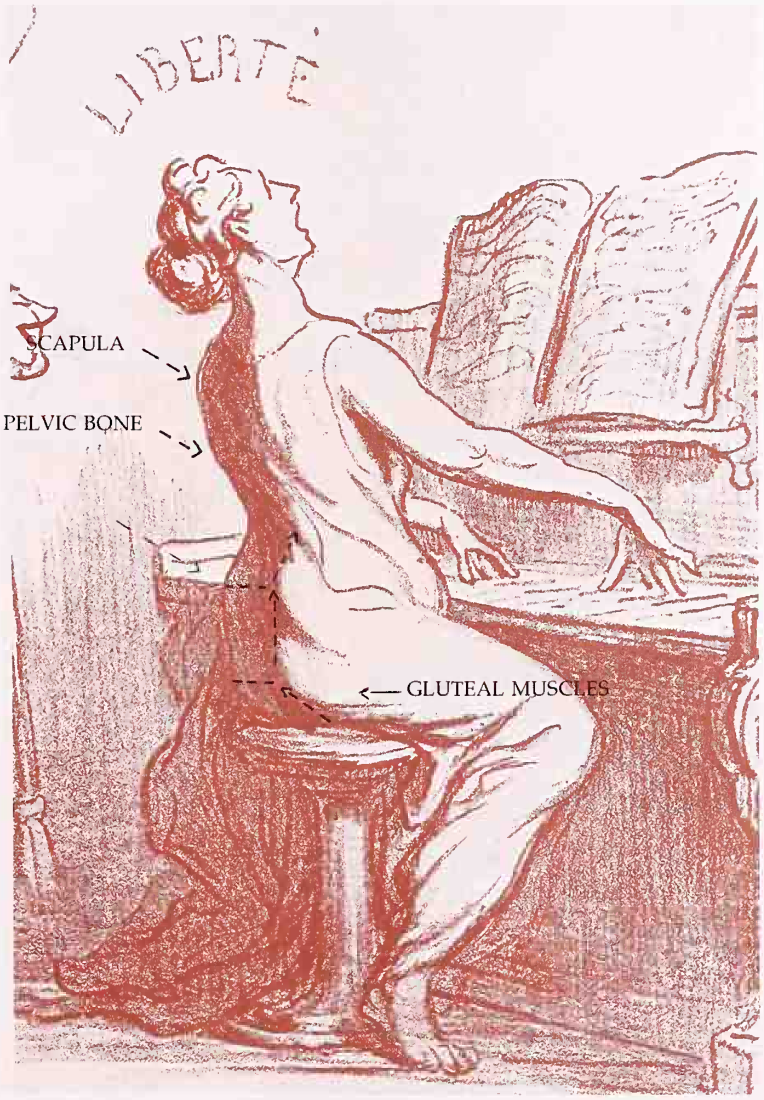
8-7

The plan of related positions for the origin of folds in various parts of the figure should be examined with care. The origin of folds, noted and established early in the drawing, will help avoid confusion later.

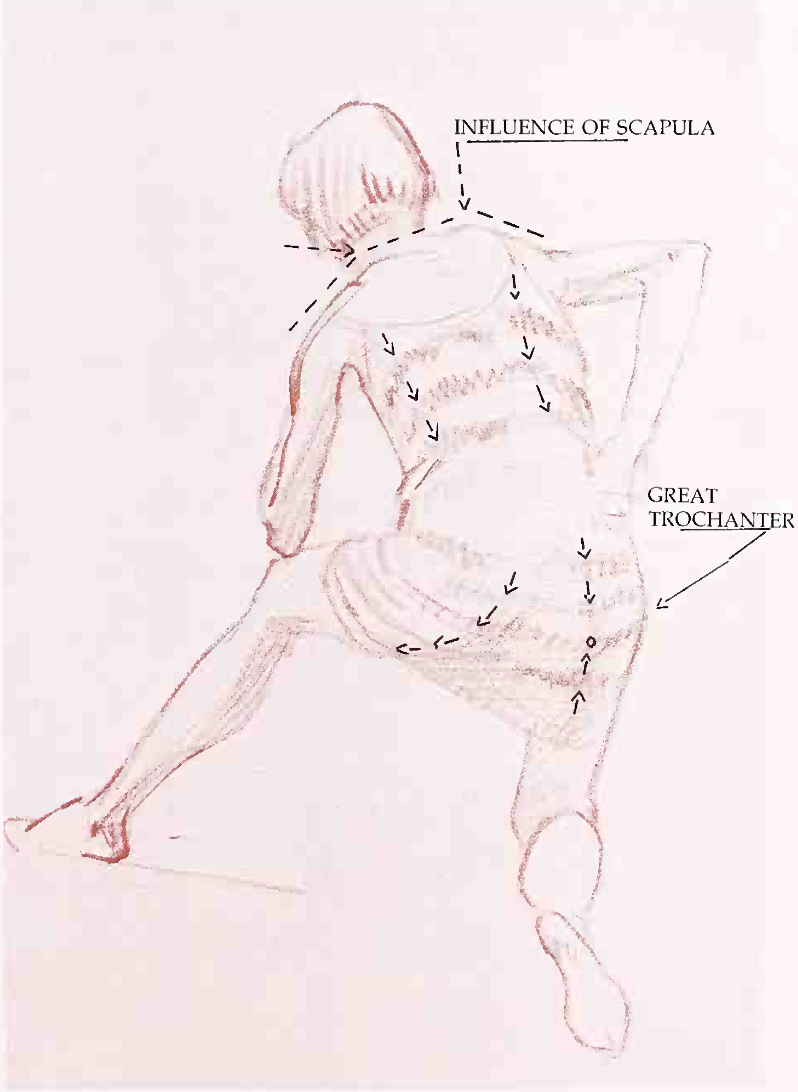
Experimental movement observed in a mirror presents a convenient means to study drapery. Simply bending an arm or taking a step will illustrate the mechanics of drape formation. The specifics of long folds may be altered by movement, but the points of origin of individual folds remain surprisingly constant.

Not only direct observation, but the diagramed analyses of a number of master drawings will provide a guide to spatial order in the draped figure. The relationship of smaller units to the broader architecture of major volumes presents a hierarchy of structure that is a constant challenge in drawing.

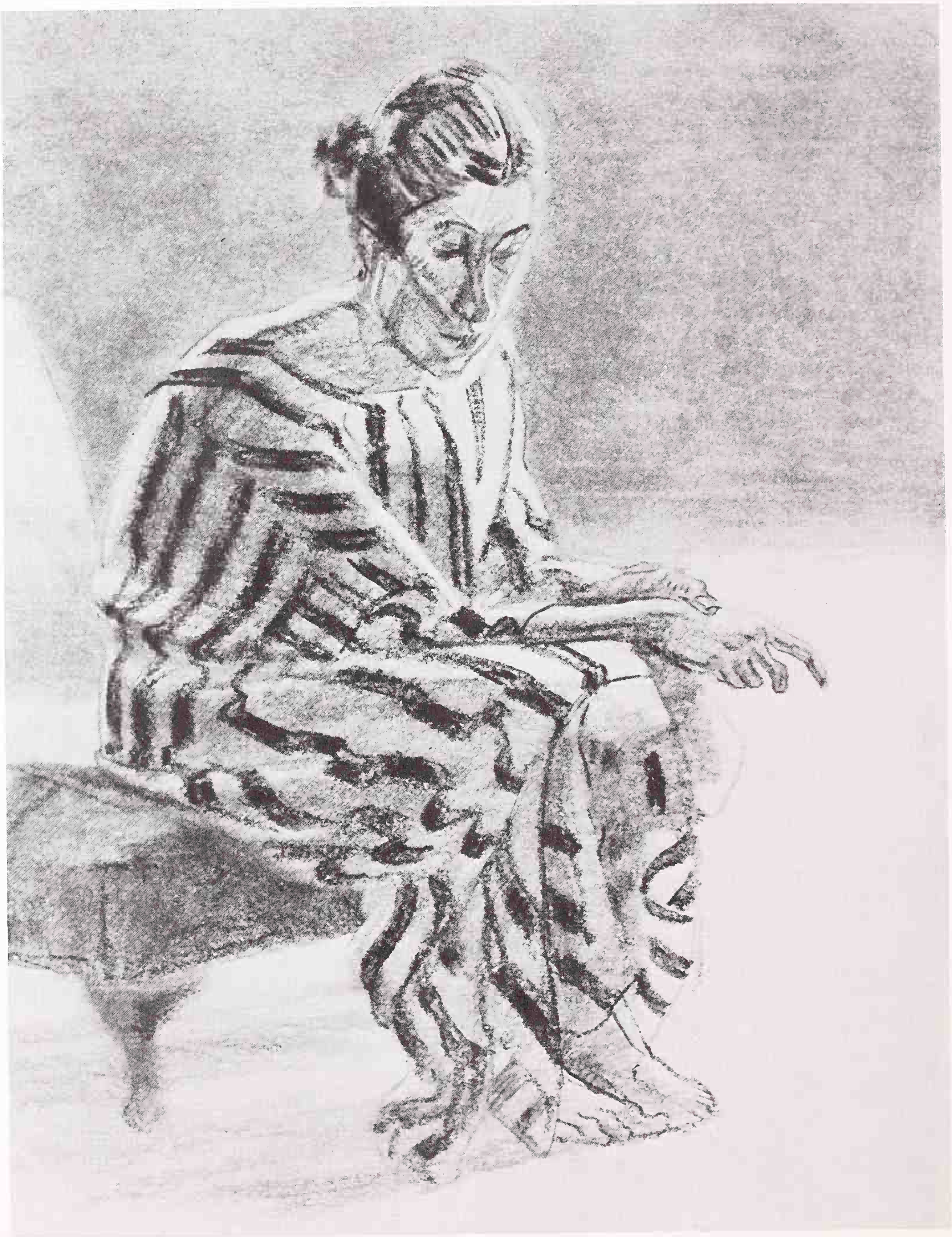
The illustrations for this section show a number of important skeletal and muscular points to consider in drawing the costumed figure [8-7 to 8-13].



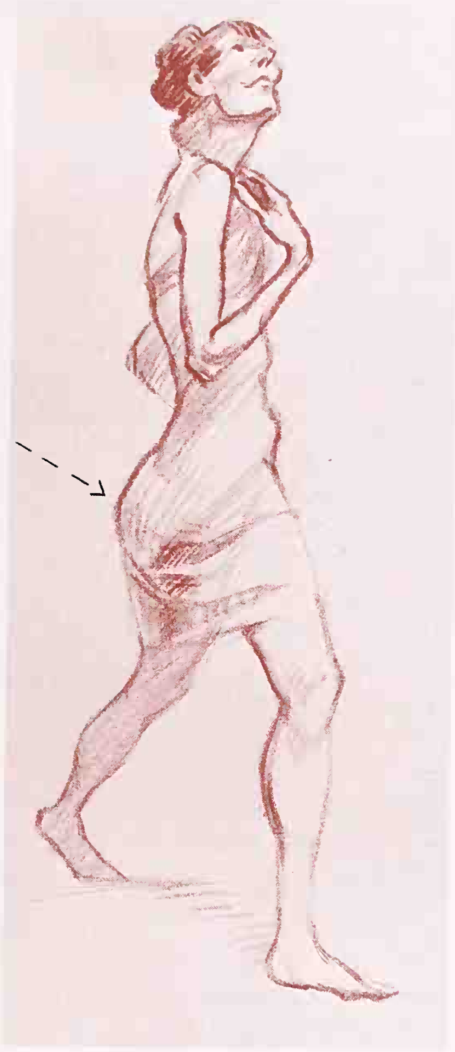
8-8



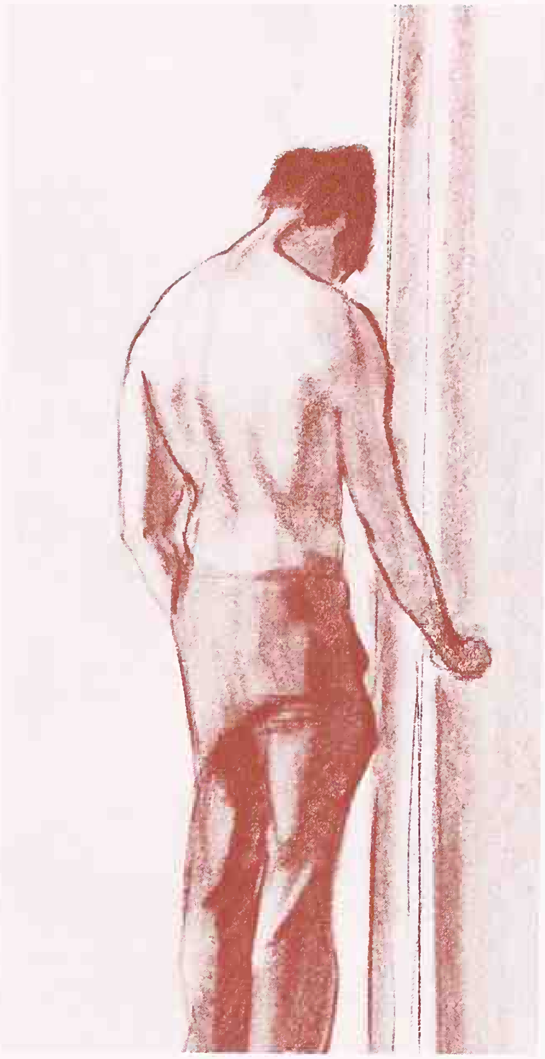
8-9



8-10



8-11



8-13

8-10

Stripes and Structure: Seated Figure in Striped Robe by the author. (Photograph by Iso Papo.)

Striped costumes can disguise structure. Stripes may also emphasize the direction and perspective of planes. The vertical stripes from the shoulder to the hip on the side of the figure and from the collarbone to the chest on the front of the torso show the volume of the torso.

8-11

Study of Girl Stepping by the author. (Photograph by Iso Papo.)

The tension of folds of drapery follow and reinforce changes of plane within the volume of the thigh and hip.

8-12

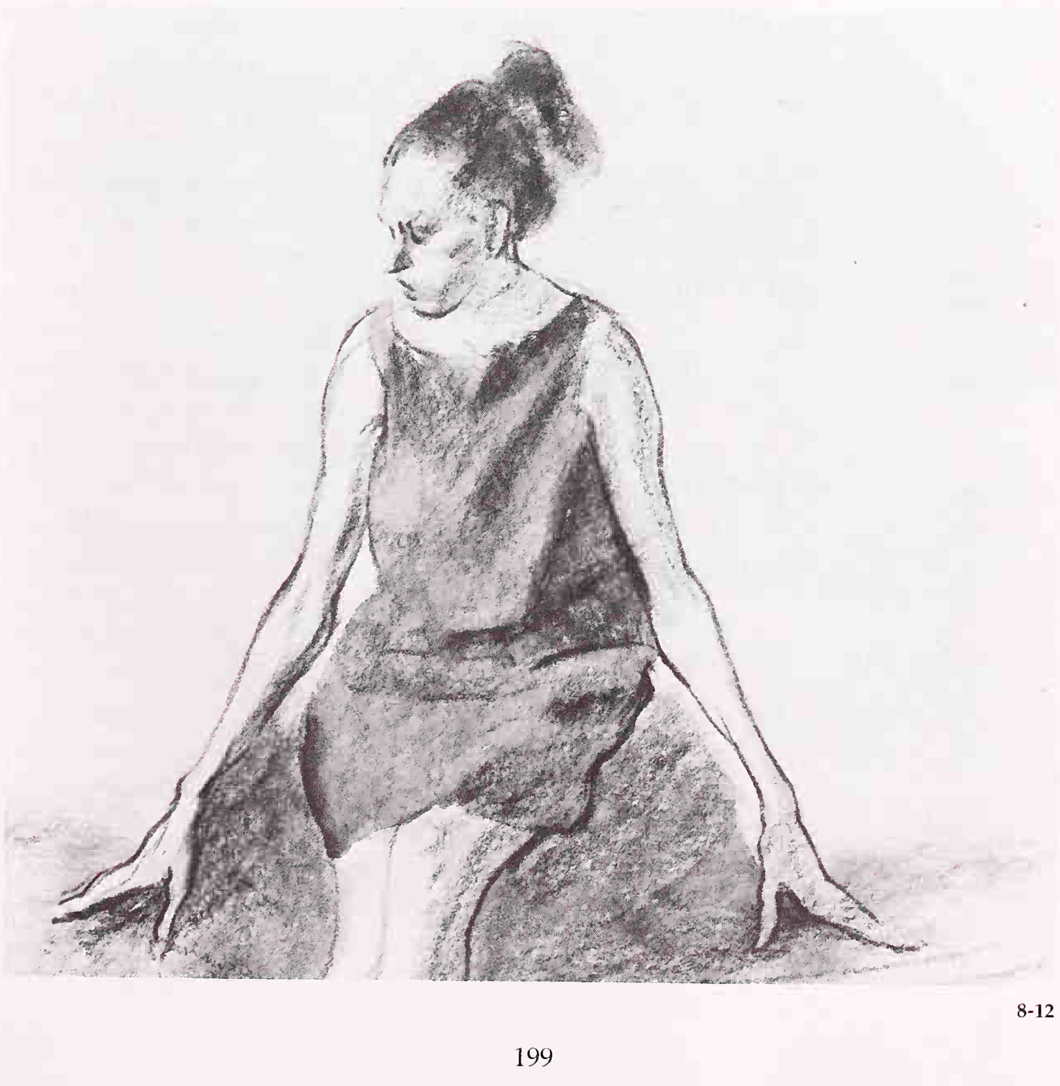
Girl in a Mini-Dress by the author. (Photograph by Iso Papo.)

The dark triangular plane beneath the right arm indicates a foreshortened side plane of the ribs. The angle in the dark fold at the waist reinforces the relationship between side and front planes.

8-13

Study of Boy with Sagging Slacks: Back View by the author. (Photograph by Iso Papo.)

The strong columnlike form of the leg provides clear support for the torso. The loose folds do not obscure the important continuous form of the leg.



8-12

CHAPTER 9

PLANNING AN ANATOMY COURSE

Artistic anatomy is a service course. It augments figure study in drawing, painting, and sculpture. Anatomy can be adapted to various visual-arts curricula and presented as a one-semester or a two-semester course. A third alternative, a short unit of anatomy instruction, may be integrated into a general drawing course (see outlines of teaching plans at the end of this chapter).

Anatomy for the art student should be introduced at an appropriate level. In the context of a four-year professional art program, it should not be offered before adequate drawing skills have been cultivated. The entering freshman with limited drawing experience may have difficulty assimilating complex surface anatomy. However, if artistic anatomy is deferred until the junior or senior year, the student misses the full opportunity to apply this knowledge as an aid to figure drawing and painting at the advanced level. Thus, the sophomore year seems to be an appropriate level to present artistic anatomy. By the second year, some acquired drawing skills exist to accommodate anatomic complexity and prepare the student for advanced figure drawing in the third and fourth years.

A course of study in artistic anatomy should, ideally, be integrated with specific exercises in related courses. Discussion among faculty in drawing, painting, and sculpture may suggest parallel class assignments that will interact beneficially with artistic anatomy. For example, a portrait project in painting, drawing, or sculpture can be coordinated with the study of the skull and the muscles of facial expression. This places anatomy in a proper supportive role in developing a visual language. The development of an additional congruous sequence of assignments augments the teaching program. A faculty curriculum committee might carry out a study to determine the feasibility of coordinating course content among two or more courses.

Drawing from life is essential to an understanding of body structure. Passive learning from lecture and text, isolated from practice, will have no lasting impact or value. Discourse *plus* studio life drawing are essential to unite knowledge and application.

A sophomore anatomy drawing course of nine hours per week can be integrated successfully in a basic core curriculum. This distribution of hours will permit a common three-hour weekly meeting of all students with a general lecture for one hour and study drawing from the skeleton and muscle casts for two hours. Smaller sections would meet separately for two additional sessions of life drawing (three hours each) for a full six hours of life drawing. Obviously, if more drawing time is available, progress should be greater.

THE SLIDE LECTURE

An illustrated lecture of one hour is generally sufficient. This will cover the course content and avoid fatigue or boredom. A skeleton, slides, charts, or large drawn anatomical diagrams are essential for visual explanation. A number of short films on anatomy, dance movement, physical education, and art will vary the presentation and stimulate interest. Equipment should include:

two slide projectors, two screens, lectern
slide collection: anatomy slides; drawing, painting, and sculpture slides
audio equipment

A well-researched slide collection is an important resource for an anatomy course. It may take ingenuity and special effort to compile slides of the skeletal and muscular systems. Some material is available through firms listed in the Appendix: Sources of Supply. Other slides will have to be commissioned. Slides may be taken from an actual skeleton, plaster muscle casts, charts and medical diagrams, and from the living model.

A lecture presentation with two projectors is advisable. This permits direct comparison, a very effective teaching device. Suggested anatomic comparisons include:

1. Pairing a detail of a master drawing (or painting or sculpture) with its skeletal or muscular equivalent.
2. Comparing two views of the same anatomic structure (for example, side and front of skull).
3. Illustrating two opposing muscle functions (for example, flexion and extension of biceps and triceps). Additional comparisons will occur to the instructor. An occasional film will offer a welcome variation in this plan.

DRAWING FROM VISUAL AIDS (Skeleton and Muscle Casts)

Following the lecture, visual aids can be exhibited for immediate examination and study. Careful drawings of the relevant skeletal or muscular parts should be developed each week. In addition, permanent displays of casts and skeletons are desirable. Students should be encouraged to draw continually from anatomic models. Glass cabinets and Lucite cases on wheels permit both mobility and protection for valuable and fragile skeletons and plaster casts. Space permitting, a studio area or well-lighted corridor should be set aside for permanent displays of anatomic material.

THE LECTURE-DEMONSTRATION

The art department may not have access to film and slide projectors or have adequate funding for visual aids. The alternative for a program with a limited budget is the economical lecture-demonstration. The artist-instructor may execute an elaborate skeletal-muscle diagrammatic drawing to accompany and support a spoken commentary. The drawing can be executed in two or more lecturer's colored chalks on large four- by eight-foot sheets of paper.

This format assumes a fluent knowledge of anatomy, respectable competence as a draftsman, and a capacity to synthesize drawing performance and oral explanation. Confident stage presence and good voice projection are desirable attributes for this method of presentation. A lecture-drawing performance, to be effective, requires a near concurrent flow of dialogue and drawing. Long silences while sketching or lengthy vocal description unaccompanied by drawing may prove confusing or distracting.

The lecture-demonstration of the skeleton should illustrate and explain the major features of each bone or group of bones.

Minor details and irregularities of surface should not be emphasized (or included). Emphasis should be on the significant features of the bones and aspects that directly influence surface form in the figure.

The lecture-demonstration on the muscles will require an initial rudimentary indication of the bones to which muscles attach. Muscles should be drawn from the point of origin (first) to the point of insertion (second), in that order.

The third important area to be covered is the action or actions of the muscle.

Filmed or taped rehearsals before the lecture will identify awkward silences and distracting mannerisms and help perfect a balanced interplay between commentary and drawing. The use of notes should, if possible, be avoided. (This usually interrupts continuity. Notes should be kept available or be used by the beginning instructor.)

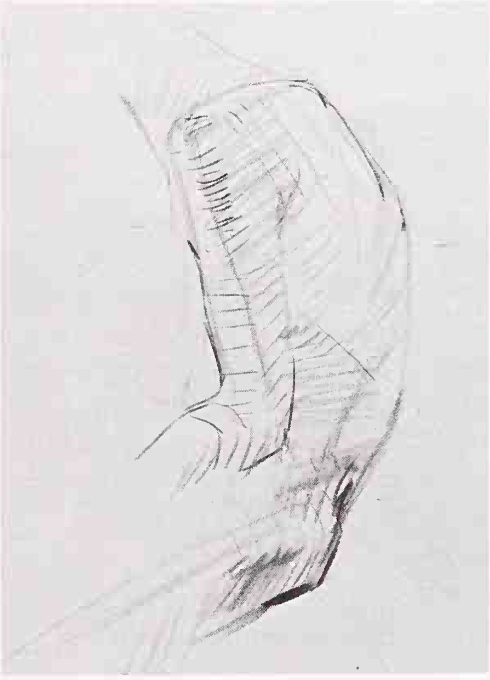
DRAWING FROM LIFE

Surface anatomy is most effectively inspected by direct drawing from the nude. The greater portion of course time should be devoted to drawing that part of the figure covered in the lecture. A few short, strained action poses can introduce the drawing session and can be adapted to illustrate muscle action. For example, alternate slow motion gestures can demonstrate flexion and extension, pronation and supination, abduction and adduction. One half hour may be devoted to gesture drawing. See section on gesture (page 27) for specific class exercises.

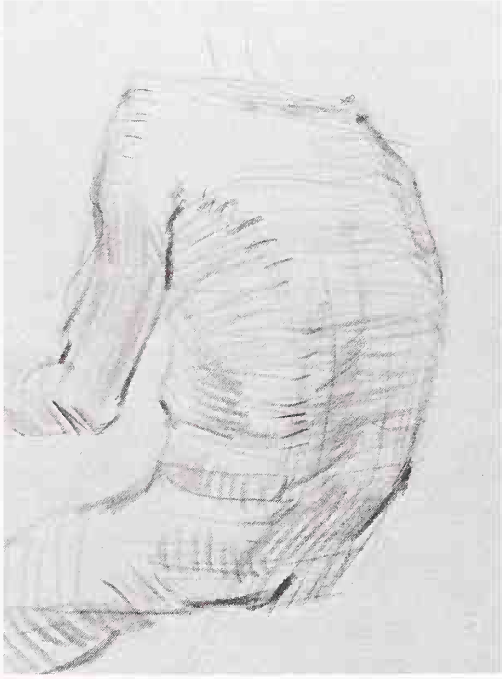
The sustained pose offers the greater value for anatomy education. The two-and-one-half-hour-long pose should emphasize the content of each weekly lecture. Large skeleton and muscle charts may be placed near the model for comparison and direct visual analysis.

Models should be chosen with care. Generally lean, athletic individuals are best suited to the anatomy class. On a well-developed model, form and function can be clearly illustrated.

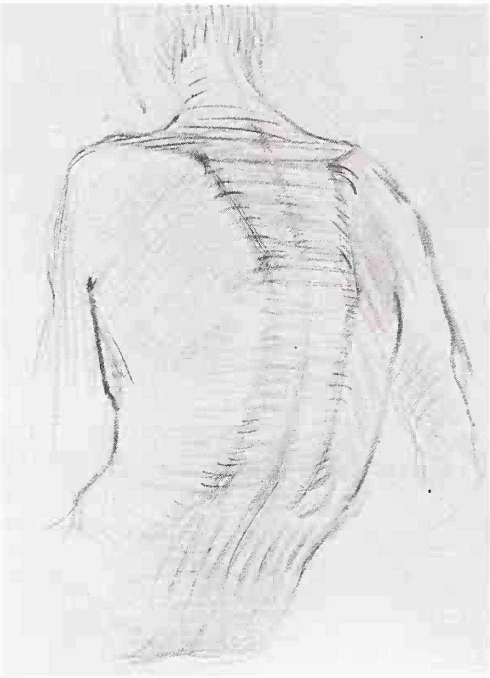
One variant in life drawing can combine the long pose with the gesture study. By anchoring one foot in a fixed position, the model can move alternately between two poses, holding each for ten minutes. The two poses can be drawn on the same sheet of paper with both studies originating from the stationary limb. There will be some overlap in the stationary leg.



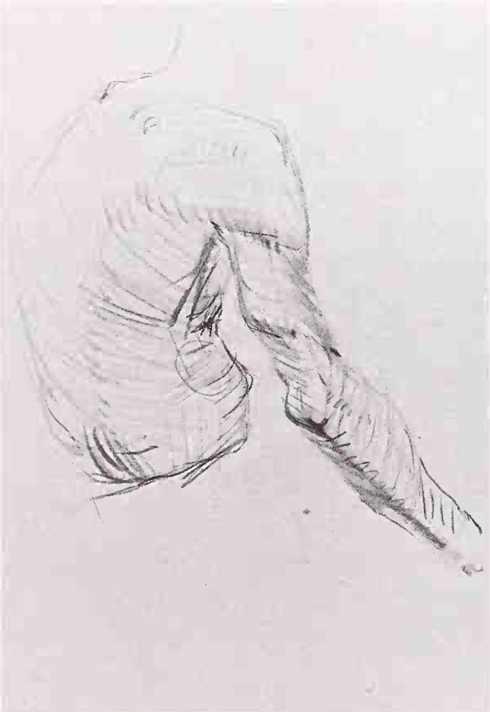
9-1



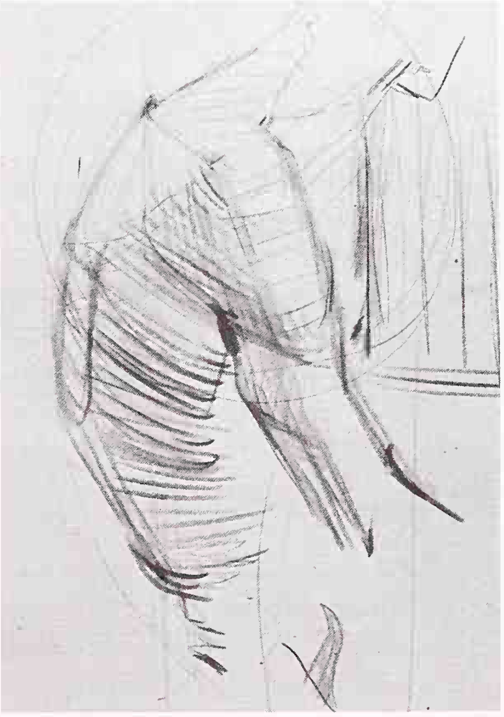
9-2



9-3



9-4



9-5

9-1, 9-2, 9-3, 9-4, 9-5

Class Critiques by the author. (Photograph by Iso Papo.)

The instructor's advantage in a drawing class. The sequence of class critiques indicate the value of identifying form strucure from a number of related but different points of view. He circulates around the model examining the forms of the figure from many viewpoints. This provides many clues to the surface structure that may not be apparent from a single viewpoint. It is wise for students to take a moment to view the pose from more than one location. This practice is especially helpful when plane direction from a single viewpoint is difficult or unclear.

Careful, controlled, and focused lighting will help clarify anatomic structure. Harsh spotlights should generally be avoided as they cast hard-edged shadows that often cut up the form illogically and disguise rather than reveal the underlying anatomy.

FILMS

A number of short films on anatomy are available on a rental basis for a modest fee. Many universities have extensive media resources and educational film services. (University film rental services are listed in the Appendix: Sources of Supply.) Films may also be obtained from local public libraries. Catalogs are available on request or for a modest fee. Most films are oriented toward health, posture, and nutrition for the young high school audience. They do contain clear descriptive information on anatomy, fluoroscope (moving X-ray) photography of skeletal action, animated diagrams, and close-up views of articulations and muscles.

Films offer useful added insight into body structure and action. Other categories of film can provide valuable instruction. Short films on dance and physical education often have slow-motion segments revealing muscle action to advantage. Art films on the works on Michelangelo, Leonardo, Rubens, and other artists will instruct and inspire. Imagination and research will contribute an exciting supplement to the lecture. Suggestions for films are listed in the Appendix, page 234.

THE SHORT ANATOMY STUDY UNIT

In smaller schools or limited studio programs, anatomy may be condensed into a unit of study within a general drawing course. This agenda would most likely be confined to a broad examination of the skeleton with emphasis on the articulations (shoulder, elbow, knee, etc.) and a few important muscles. Outside drawing assignments, recommended reading, and drawing from life would complete the anatomy instruction. This study unit can vary in length from two to four weeks (or longer; see study outline, page 205).

Abbreviated Four-Week Study Plan

Week 1	Skeleton and structure of articulations
	The articulations as origin of planes
Week 2	Skull and portrait
	Head study from casts, life masks, and model
Week 3	Facial muscles (muscles of expression): zygomatic, masseter
	Torso muscles (broad and flat): pectoral, rectus abdominus, latissimus dorsi, trapezius, external oblique
	Muscles of limbs (spindle shaped): biceps, triceps, gastrocnemius, quadriceps, hamstrings.
	Origin and insertion—tendon and muscle
Week 4	Figure study—skeletal and muscle
	Arm studies
	Leg studies
	Torso studies
	Head and neck studies

One-Semester Syllabus: Skeletal and Muscular Systems (lecture, one hour; drawing, 2 hours)

Lecture		*Life Drawing*
Week 1	Introduction to the skeleton	Gesture and figure
Week 2	Skull	Head
Week 3	Vertebrae, rib cage	Torse (profile)
Week 4	Shoulder girdle, arm, hand	Upper torso and arm
Week 5	Pelvic girdle, leg, foot	Hip and lower torso and leg
Week 6	Introduction to the muscles	Figure
Week 7	Muscles of the head	Head (portrait)
Week 8	Muscles of the neck	Head and neck
Week 9	Muscles of the torso	Torso back and front
Week 10	Muscles of the arm and hand	Arm study
Week 11	Muscles of the pelvis and thigh	Leg study and hip
Week 12	Muscles of the leg and foot	Leg study
Week 13	Review of bones and muscles	Full figure

Complete portfolio due—end of first semester
Examination
Text: *Human Anatomy and Figure Drawing* by Jack N. Kramer
Films to be shown: *Human Body: The Skeleton*
Spinal Column
Human Body : Muscular System
Tissues of the Body

Two-Semester Syllabus: Skeleton (first semester) (lecture and drawing from the skeleton and model)

Lecture		*Life Drawing*
Week 1	Skull	
	Film: *Human Body: The Skeleton*	Head
Week 2	Cartilage, skull	Head features
Week 3	Vertebral column	Torso
	Film: *Spinal Column*	
Week 4	Thorax	Torso
Week 5	Shoulder girdle	Upper torso
Week 6	Arm	Arm
Week 7	Hand	Hand
Week 8	Pelvis (front)	Hip (front)
Week 9	Pelvis (back)	Pelvic region
Week 10	Leg	Leg
Week 11	Foot	Foot
Week 12	Proportion	Full figure
Week 13	Review	Full figure
Week 14	Review	Full figure

Complete portfolio due—end of first semester

Two-Semester Syllabus: Muscles (second semester) (lecture and drawing from muscle casts)

Lecture		*Life Drawing*
Week 1	Introduction Film: *Human Body: Muscular System*	Model
Week 2	Head	Model
Week 3	Head, features, cartilage	Model
Week 4	Neck, cartilage, deep muscles	Model
Week 5	Neck muscles Film: *Tissues of the Human Body*	Model
Week 6	Torso	Model
Week 7	Torso	Model
Week 8	Upper Arm Film: *Muscles and Bones of the Body*	Model
Week 9	Forearm	Model
Week 10	Forearm and hand	Model
Week 11	Hip and thigh Film: *Ballet with Edward Villela*	Model
Week 12	Thigh	Model
Week 13	Thigh and leg Film: *Michelangelo*	Model
Week 14	Leg and foot and semester review	Model

One Semester Regional Plan Based on *Human Anatomy and Figure Drawing*

Week 1	Skull
Week 2	Muscles of expression (facial)
Week 3	Vertebral column (cervical, dorsal, lumbar)
Week 4	Muscles of neck
Week 5	Rib cage, shoulder girdle, pelvis
Week 6	Muscles of torso front and back
Week 7	Upper extremity: bones of the arm and hand
Week 8	Upper extremity: muscles
Week 9	Lower extremity: bones of leg and foot
Week 10	Lower extremity: muscles
Week 11	Review
Week 12	Review

REQUIRED WORK

The following material may be duplicated and distributed to all classes:

1. The semester syllabus
2. A glossary of important anatomical terms and a list of the bones and muscles to be covered in the course (which will avoid the necessity of spelling unfamiliar anatomical terms)

Homework

A drawing of the bones and group of muscles covered in each weekly lecture is to be done by each student.

If possible, drawings should be done from an actual skeleton (kept in an accessible glass or Lucite case).

Muscles should be drawn from a three-dimensional cast of the muscles rather than from a book diagram.

Drawings from flat diagrams offer only minimal aid and should be utilized only when other visual aids are unavailable.

Outside Assignments

The independent study assignment is an important supplement to classwork. Weekly homework in anatomy will sustain continuity by added drawing practice and help secure in the memory recently acquired knowledge of body structure. But the assignment of homework should be seen in the context of the total curriculum in which numerous other course demands are competing for the student's attention.

Once the total student workload has been assessed, a balanced weekly outside anatomy requirement can be considered. It may be a reading in the text or the study of nomenclature, but for the figure draftsman, a pertinent drawing assignment will contribute most to the development of figure-drawing skills. The exercises for use with each chapter in this text may be used as is or as a suggestion for original assignments.

Analysis of a Master Drawing

One comprehensive semester exercise of educational value is the skeleton and muscle analysis of a master drawing (or painting or sculpture). The project is equivalent to a term paper in a liberal arts course (see illustrations 9-6 to 9-12).

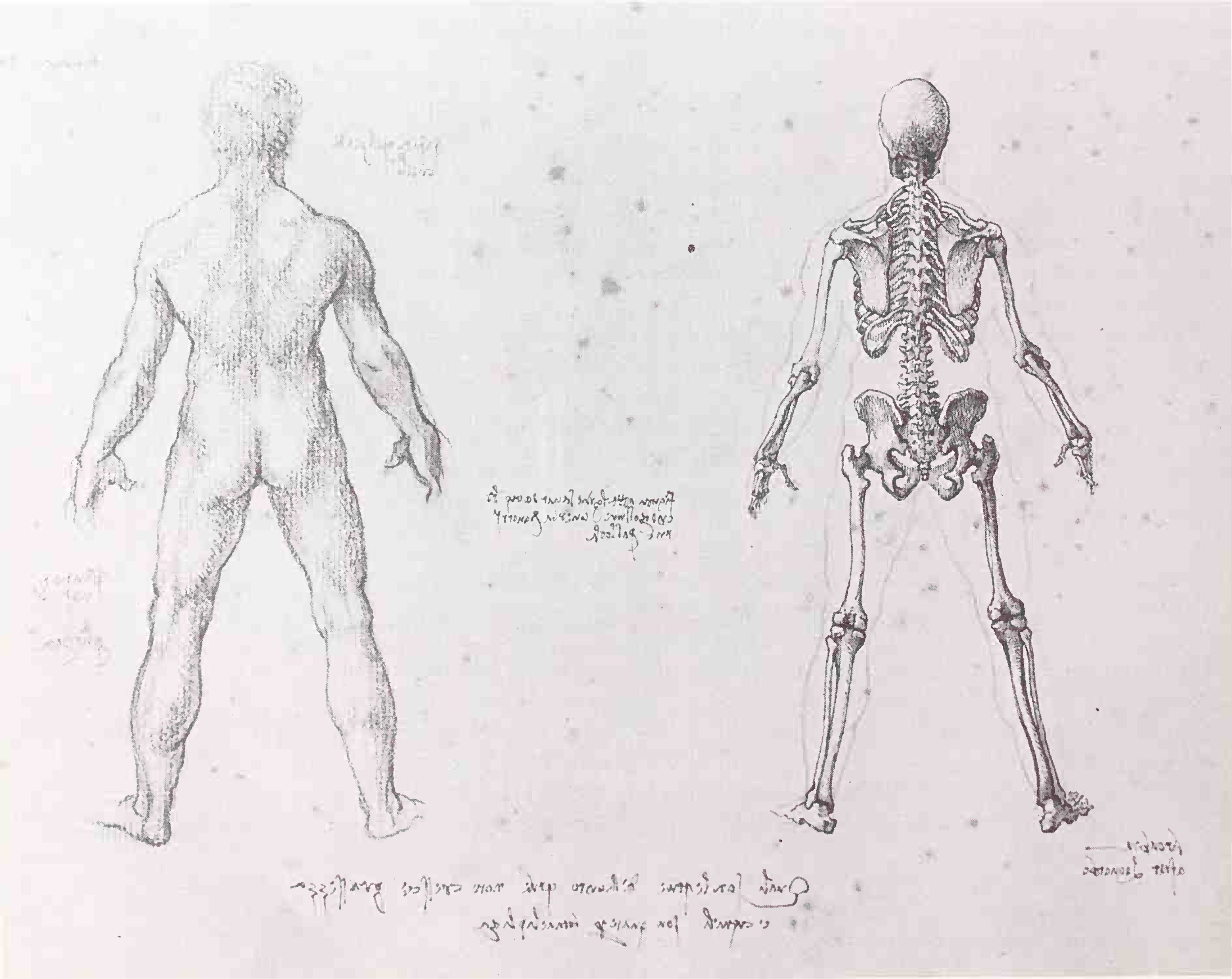
Three careful anatomy study drawings developed from a master drawing (painting or sculpture) will be required. This task should be assigned early on and reviewed periodically by the instructor before it is handed in at the end of the term. Choice of a work of art for analysis will require prudent research. Students should review their choice of reproduction with the instructor to be sure it is suitable. It must be large and legible and sufficiently complete to cover major body forms. The works of Renaissance artists are particularly relevant for this exercise.

On the other hand, caution must be exercised in selecting a photograph of a work of sculpture. Reproductions of highly polished bronze sculpture are often quite useless. Shiny bronze figures with bright reflective surfaces and sharp irregular highlights may completely disguise pertinent anatomic information and should be avoided. Generally, if the choice is sculpture, works in marble, clay, terra-cotta, plaster, wax, and bronze with a muted patina will photograph best to reveal anatomic structure.

The sequence of studies in the analysis of a masterwork is important. First, to become familiar with the forms in the master drawing, a reconstruction larger than the original should be made: this prevents tracing. Tracing is a mechanical procedure and should be avoided at this stage. A freehand redrawing from the original reproduction will more likely sharpen visual judgment and understanding. The aim of this study is not an exact photographic facsimile but rather a reconstruction of the significant form relationships in the spirit of the original, carried out in a similar medium when practical and possible.

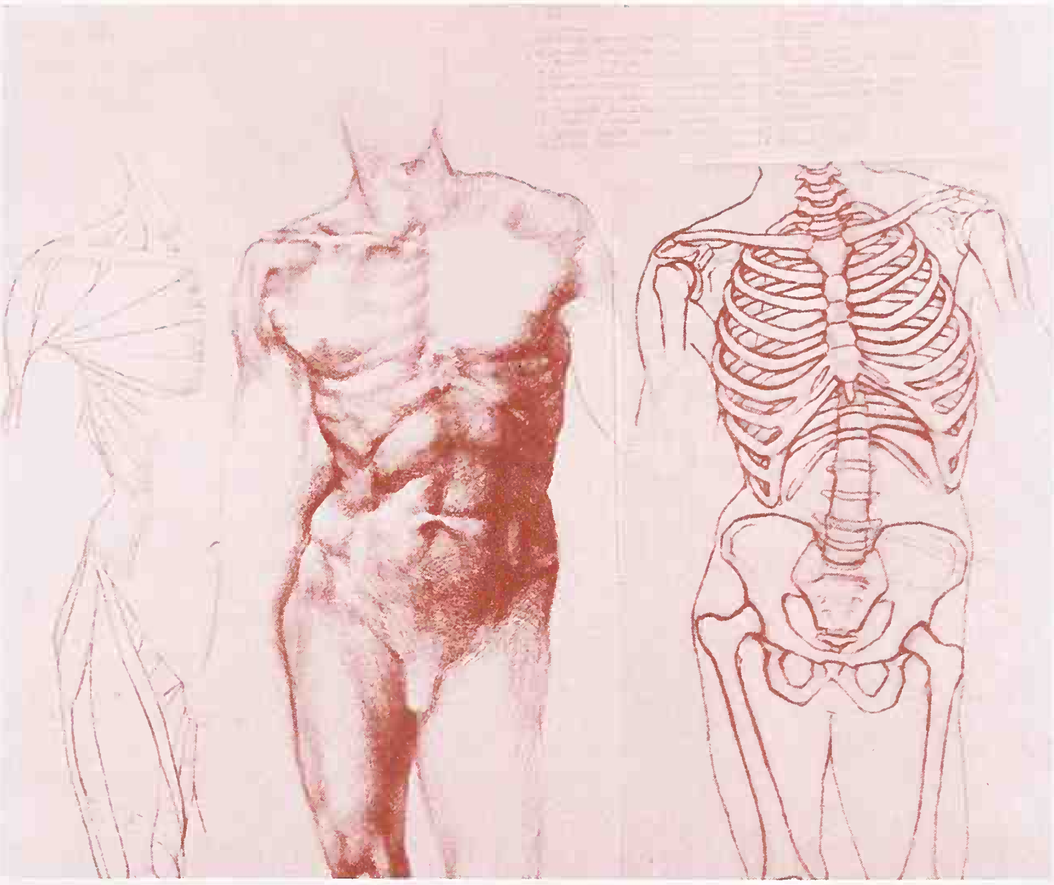
The second drawing may, however, be a traced contour copy on tracing vellum. (Vellum is sturdier than tracing paper.) Tracing at this stage is acceptable, since the focus is not on the tracing but the freehand drawing of the skeleton. Within this contour study, the skeleton may be drawn showing its influence and contact with the contour, especially at articulations, skull, and rib cage.

9-6



9-6
Analysis of a Drawing by Leonardo da Vinci, by Benjamin Aronson. (Photograph by Iso Papo.)

This student work is an exceptional reconstruction, executed with genuine reverence for the master. The analysis is taken from a drawing by Leonardo da Vinci. The "foxing" on this antique paper is genuine. With the use of sepia ink and conte, the drawing achieves an unusual verisimilitude to the original, including the mirror writing used by Leonardo. The analysis identifies significant skeletal influence on the contour and inner plane structure. For example, the wedge-shaped pelvic structure can be located by the frame of light in the hip and buttock.



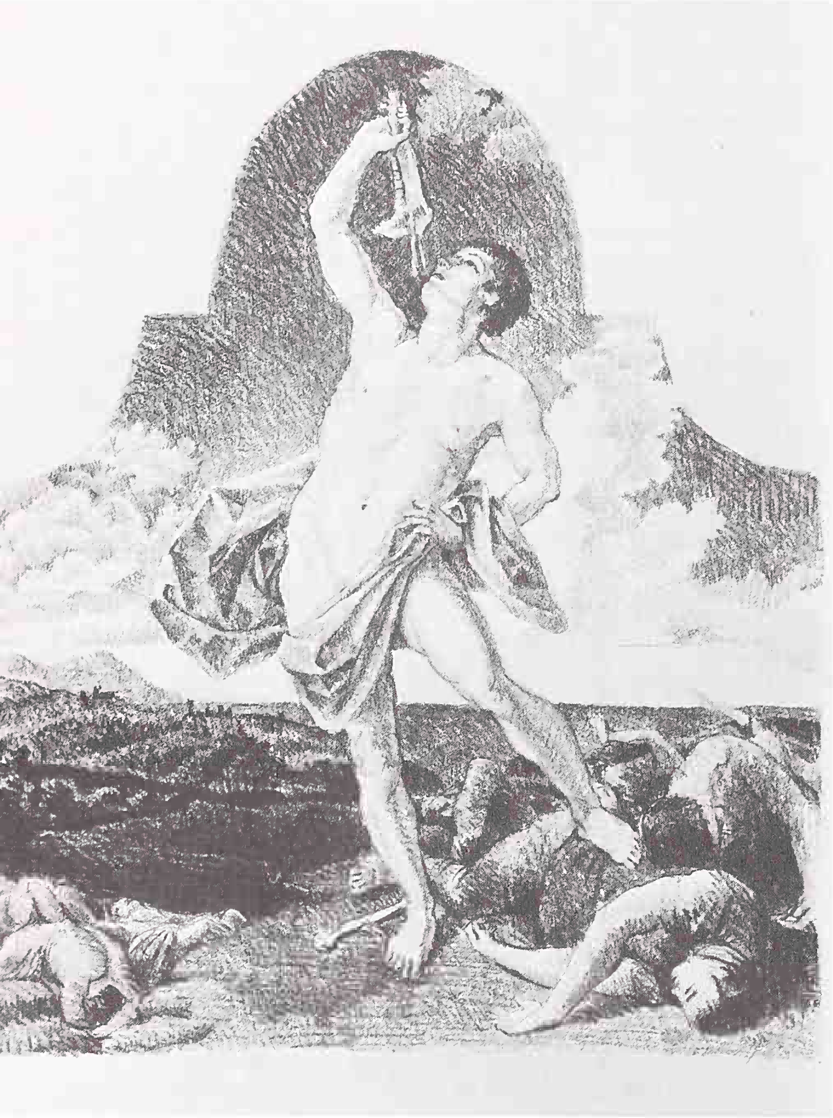
9-7

9-7
A Reconstruction and Analysis from a Drawing by Michelangelo, by Brian Bailey. (Photograph by Iso Papo.)
A student analysis of a drawing by Michelangelo (possibly a study for *David*). The rib cage analysis exhibits admirable foreshortening and relates to significant clues in the drawing with precision in the thoracic arch and lower rib curves.

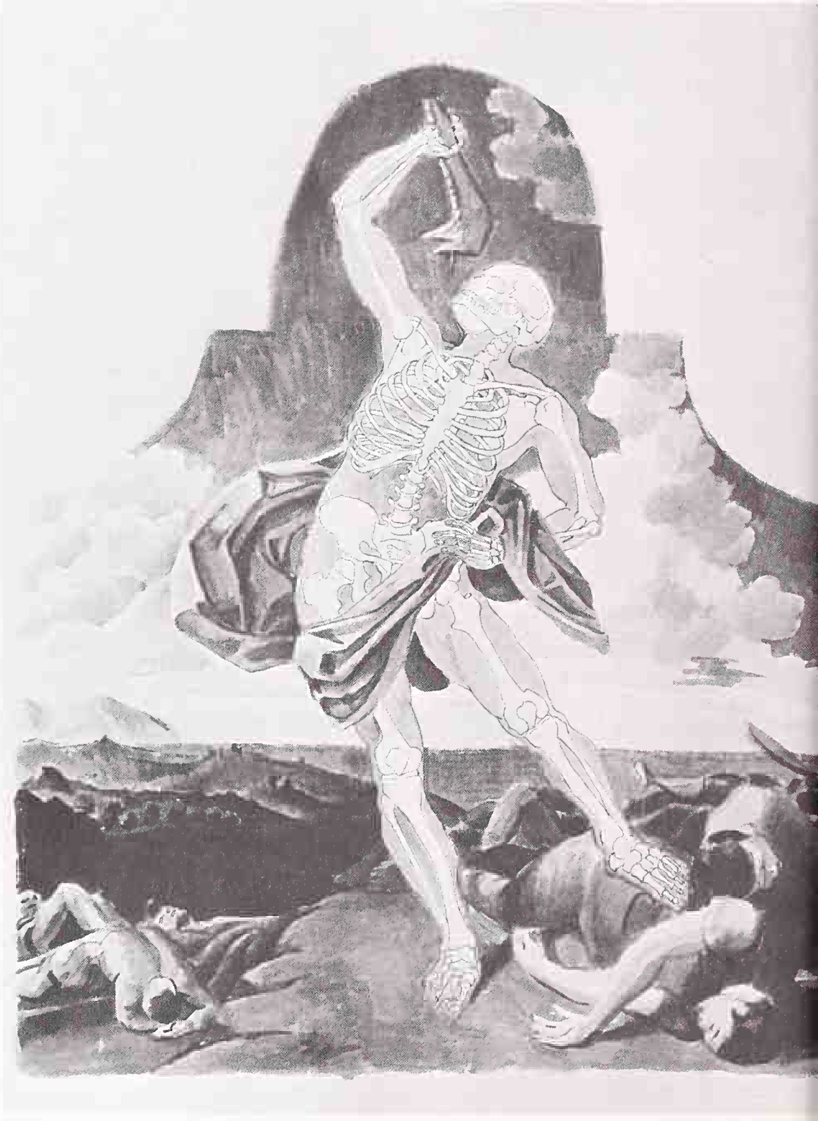
The third analysis drawing, and the most difficult, is the muscle study, which may also be carried out on a second sheet of tracing vellum. This should be done over the skeletal study to identify the origin and insertion of important superficial muscles. Constant comparison with the original drawing and reference to skeletal and muscle diagrams will help pinpoint the location of muscles. Care should be taken to adapt muscle form to the action and gesture of the original work. Muscles that influence the contour should join against the contour line [9-8, 9-9].

Colored pencil may be used to distinguish muscles from the skeleton and from the contour drawing. Modeling should be kept to a minimum on the tracings or left out entirely. Attempts to indicate muscle fiber and texture are superfluous and tend only to confuse the drawings. Labeling of each muscle may be optional but as a means of learning names, it should be encouraged.

Two classic examples of anatomical analysis from master artworks are the Salvage analysis of the Borghese Fighter and Julian Fau's analysis of the Laocoon (see figures 5-42, 5-43). Both offer useful examples of the figure in action with muscles under great stress. (Julian Fau's Laocoon is based on a nineteenth-century reconstruction. Recent scholarship has replaced the raised forearm with a sharply flexed horizontal limb.) The student analyses included follow in this tradition and illustrate an interest, in some cases, that extended the exercises well beyond the narrow limit of anatomy.



9-8



9-9

9-8

A Reconstruction by Andrew Raftery from a painting, Samson Victorious over the Philistines by Guido Reni.

9-9

A Reconstruction in Mixed Media from Samson Victorious over the Philistines by Guido Reni, by Andrew Raftery. (Photograph by Iso Papo.)

The skeleton projection provides a consistent explanation of skeletal influence in all parts of the figure. The inclusion of the elaborate landscape provides a pictorial context that reminds one of the Albinus's *Tables of Skeleton and Muscles* and preserves the context from which the analysis is taken.

9-10

A Reconstruction from a Drawing by Pontormo, by Richard Phillips. (Photograph by Iso Papo.)

9-11

Skeletal Analysis of a Drawing of a Seated Figure by Pontormo, by Richard Phillips. (Photograph by Iso Papo.)

The pelvic form has been adapted to the weight and gesture of the torso. The tibia, fibula, and femur articulations relate clearly to the contour.

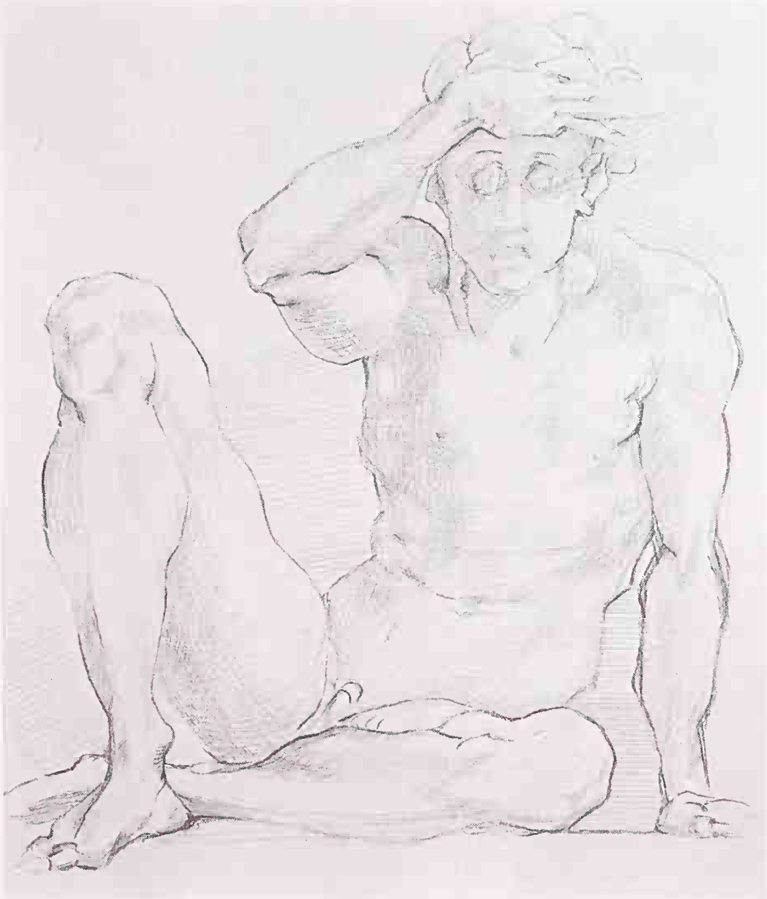
FINAL EXAMINATION AND REVIEW OF STUDENT WORK

A wide variety of alternatives are open to consideration in planning a final examination in artistic anatomy.

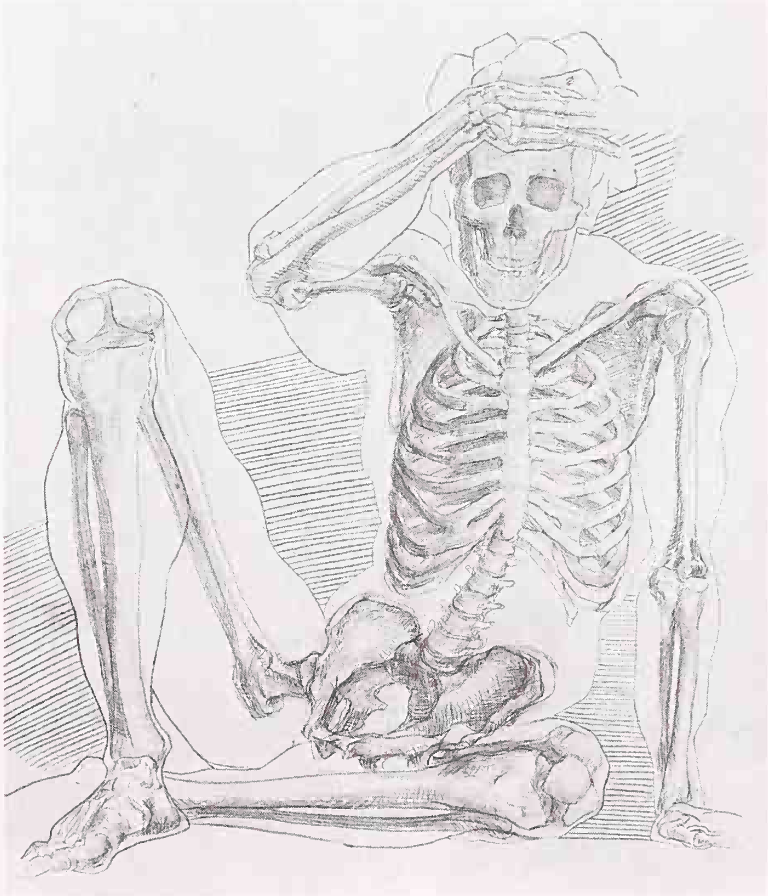
Before organizing a final examination, however, the instructor should establish the goal of the examination and its significance to the final grade. It may, for example, be a simple review of nomenclature or it may focus on a comprehensive memory drawing of the skeleton and muscle forms in a complex action. In the first case it would have minimal influence on the final grade. In the second it could significantly determine the grade.

If the course has focused adequately on memory drawing of the figure, the second drawing option, while ambitious, might be a viable examination proposal. In a large class it would probably be an unreasonable expectation from the students and a burdensome problem of evaluation for the faculty member. The instructor must also consider his own considerable workload.

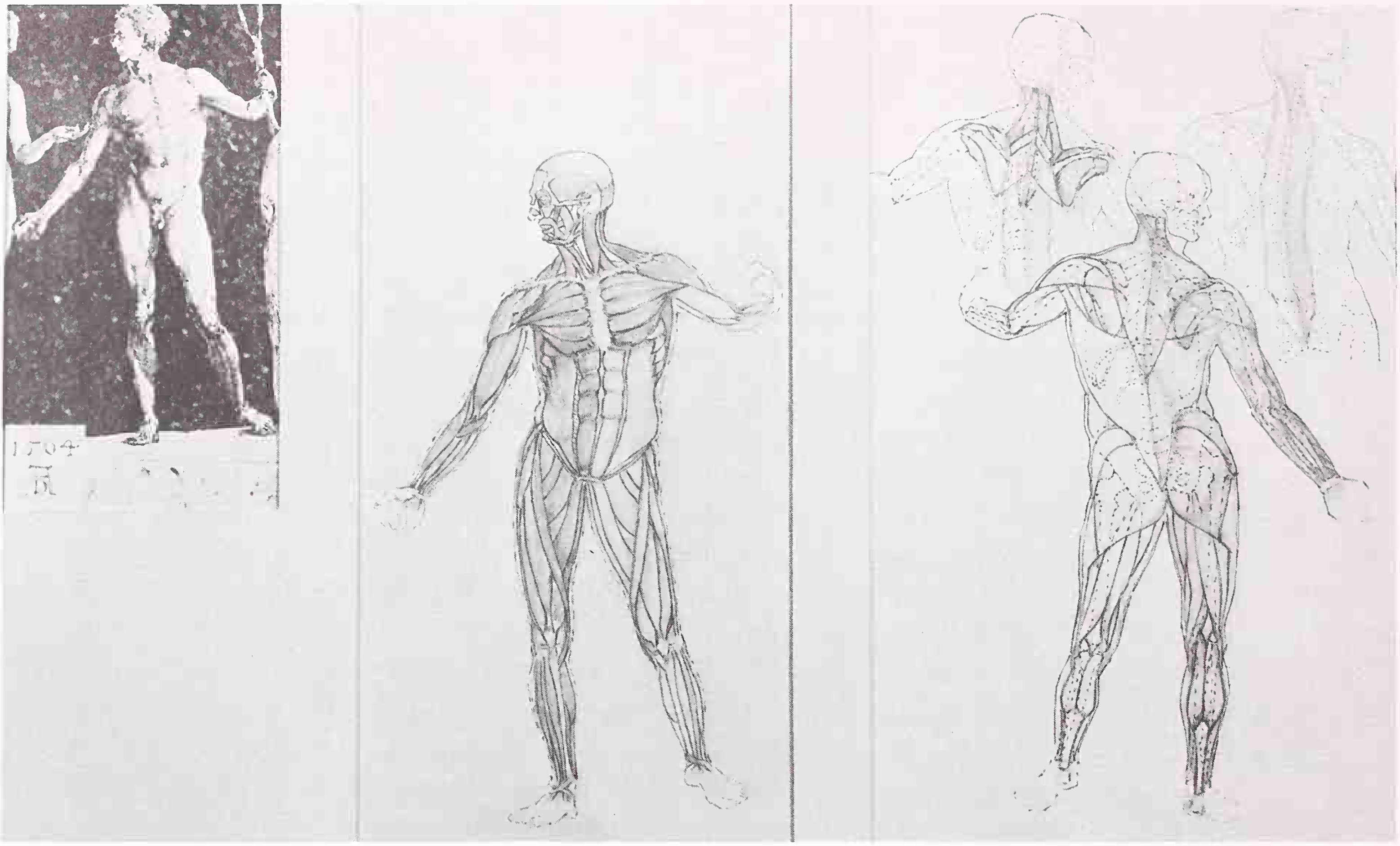
Anatomy demands weekly lecture preparation (organization of notes, slides, projectors, etc.). Preparation of visual aids (skeletons, casts, etc.) for each class, individual drawing critiques, student conferences, group critiques, informal drawing demonstrations, and periodic grade evaluation are part of an accepted faculty obligation and involve considerable time.



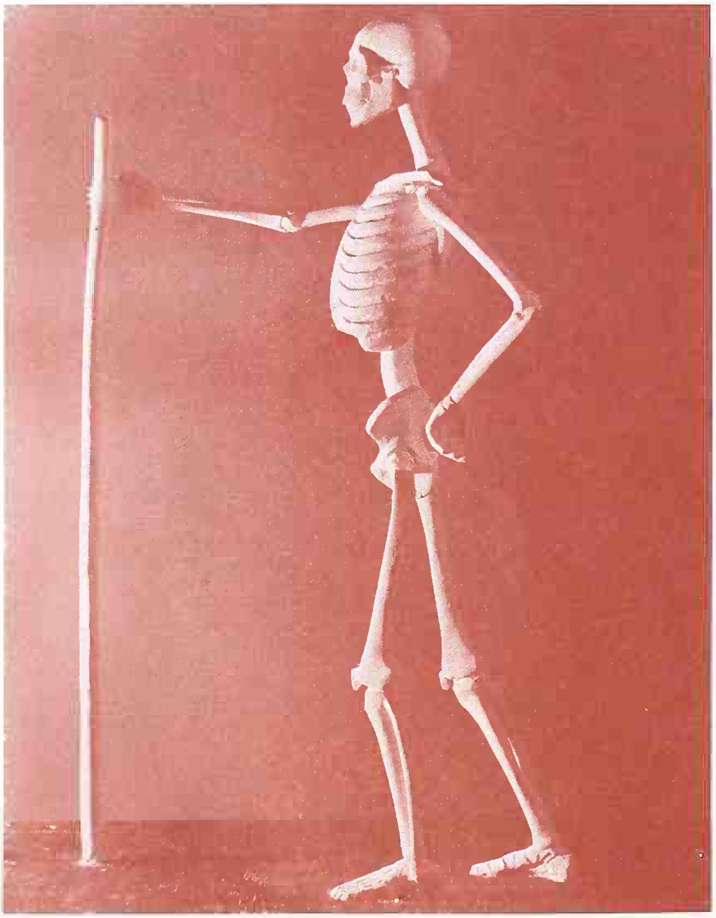
9-10



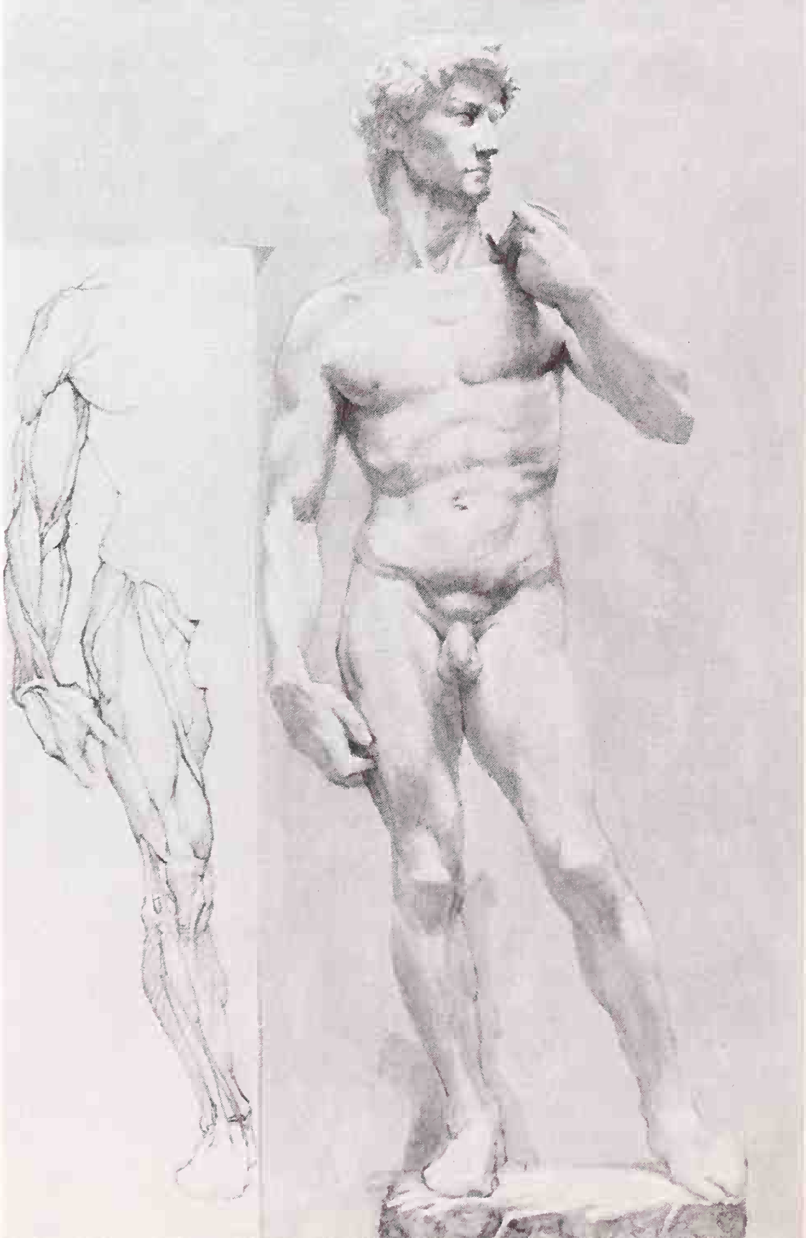
9-11



9-13



9-12



9-14

If the instructor plans a portfolio review of the semester work of each student and bases the grade on this review, the review examination must be thorough. This last option is a manageable requirement even for large classes (fifty to eighty students). The comprehensive memory drawing examination is realistic only for a small, intensely dedicated, and serious group of students.

The following sample examinations involve both nomenclature and drawing, will elicit basic information, and are easily evaluated. This type of examination would have very limited influence on the final grade. The study of artistic anatomy focuses on improved, informed figure-drawing skills. These skills are directly revealed in the accumulated drawings carried out from the model. A review of student work arranged in chronological sequence will reveal improvement in drawing to the instructor. Comparison of an early drawing with a recent work should establish this development.

If the aim of the course is to improve figure-drawing ability, the drawing pad or portfolio should be the major consideration for a final grade. Supplementary factors to be evaluated are:

1. Drawings from skeleton and muscle casts
2. Anatomy analysis of masterwork
3. Final examination
4. Optional extra work done on student's initiative
5. Attendance

Probably the best anatomy examination would consist of two memory drawings of the figure in a specific action, (jumping, diving, boxing, etc.).

One study would be the skeleton, developed with bones modeled in the round.

A second study would include the major superficial muscles in the same pose. However, the pressures of other major curriculum requirements and large class size make this examination unrealistic. Unless a great deal of anatomy drawing from memory as well as direct life drawing is included in the course content, this examination would be beyond the scope of required experience and knowledge.

For a small class, with unrestricted time to devote to anatomy, the above examination would be an appropriate and valuable test of knowledge and ability.

A realistic and feasible examination for a large class with limited time may include some important nomenclature and a modest drawing exercise testing knowledge of major bone structure and articulation and a muscle examination testing knowledge of the origin and insertion of a select group of major muscles.

Nomenclature may be tested by showing a series of drawing, painting, and sculpture slides. The instructor, by pointing out an anatomical part, would require the student to identify on paper the appropriate names of bones.

Testing knowledge of the muscles may take the form of a printed skeletal diagram and a separate list of muscles. The student locates the origin, insertion, and shape of the muscle (and tendon) on the diagram.

An anatomy course deals with a specific body of information presented in a structured format. There appears to be little room for improvisation. However, within this predictable framework some imaginative variation is possible. Each week, for example, in the life drawing sessions there is an opportunity to experiment with poses and dramatic lighting. Unique, varied, and meaningful actions of the figure may relate to a sport (for example, swinging a bat), a work chore (sweeping) or an art form (a dance gesture). Working within the limitations of formal structure offers a challenge and an opportunity to both student and instructor.

9-12

Profile View of Plaster Skeleton with Staff by Morgan Gilpatrick. (Photograph by David Abrams.)

9-13

Copy from Albrecht Dürer's Adam by Samuel Goldring. (Photograph by Iso Papo.)

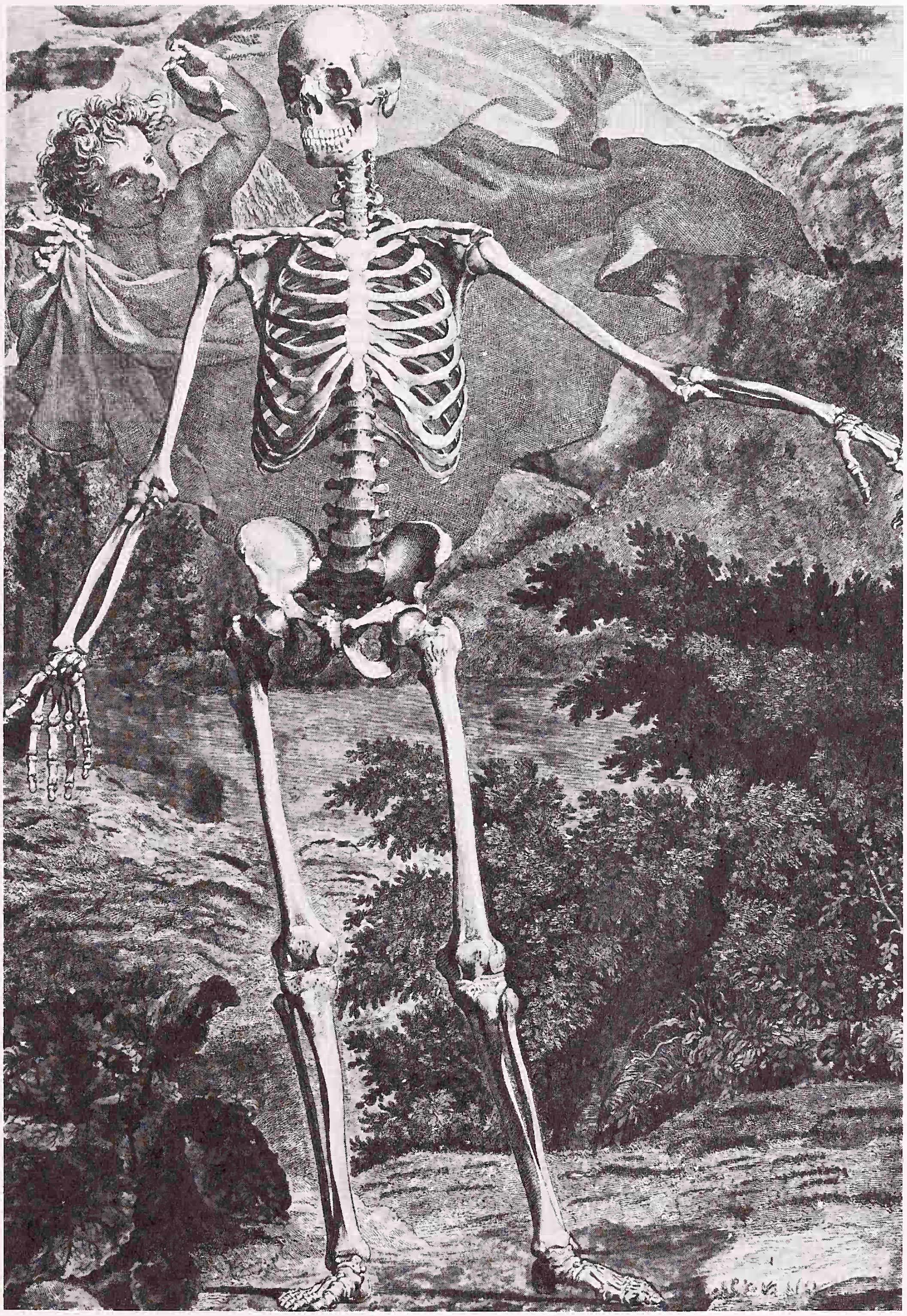
The student has shown not only a front view following the engraving but has included a reconstruction of the pose from the unseen back. Close examination of this back view is rewarding. Within the muscular analysis is an indication of the skeleton shown by a dotted line. Separate studies of the erector spinae muscle group and the elevators of the scapulae are included.

9-14

A Reconstruction of Michelangelo's David (mixed media), by Benjamin Aronson. (Photograph by Iso Papo.)

The muscle analysis of the arm and the leg bears close comparison with the sculpture. This student exercise contributes to a better appreciation of a masterwork, but it also trains the eye in the study of surface anatomy. The strain and tension evident in the muscle analysis illustrates an expressive element in the sculpture.

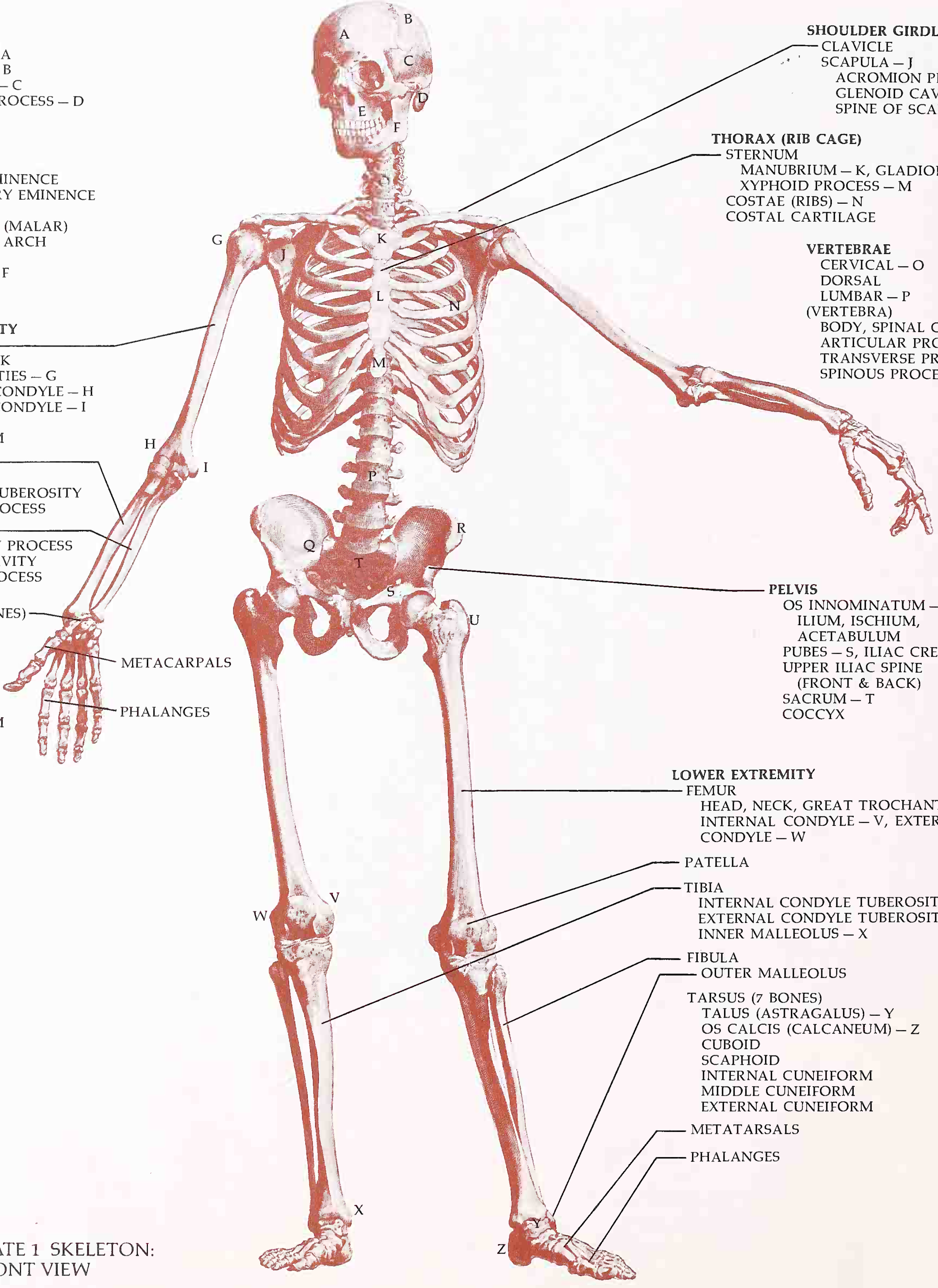
COMPENDIUM: CONDENSED REFERENCE



10-1

ANATOMICAL PLATES FOR REFERENCE

The six plates on the following pages are from *The Tables of the Skeleton and Muscles of the Human Body* by Bernhard Albinus. They are reproduced through the courtesy of the Boston Medical Library in the Francis A. Countway Library of Medicine.



SKULL
- CRANIUM
  - FRONTAL – A
  - PARIETAL – B
  - TEMPORAL – C
  - MASTOID PROCESS – D

FACE
- FRONTAL
  - FRONTAL EMINENCE
  - SUPERCILIARY EMINENCE
  - GLABELLA
  - ZYGOMATIC (MALAR)
  - ZYGOMATIC ARCH
  - MAXILLA – E
  - MANDIBLE – F
  - NASAL

UPPER EXTREMITY
- HUMERUS
  - HEAD – NECK
  - 2 TUBEROSITIES – G
  - EXTERNAL CONDYLE – H
  - INTERNAL CONDYLE – I
  - TROCHLEA
  - CAPITELLUM
- RADIUS
  - HEAD
  - BICIPITAL TUBEROSITY
  - STYLOID PROCESS
- ULNA
  - OLECRANON PROCESS
  - SIGMOID CAVITY
  - STYLOID PROCESS
- CARPUS (8 BONES)
  - TRAPEZIUM
  - SCAPHOID
  - LUNATE
  - CUNEIFORM
  - PISIFORM
  - TRAPEZOID
  - OS MAGNUM
  - UNCIFORM

METACARPALS

PHALANGES

SHOULDER GIRDLE
- CLAVICLE
- SCAPULA – J
  - ACROMION PROCESS
  - GLENOID CAVITY
  - SPINE OF SCAPULA

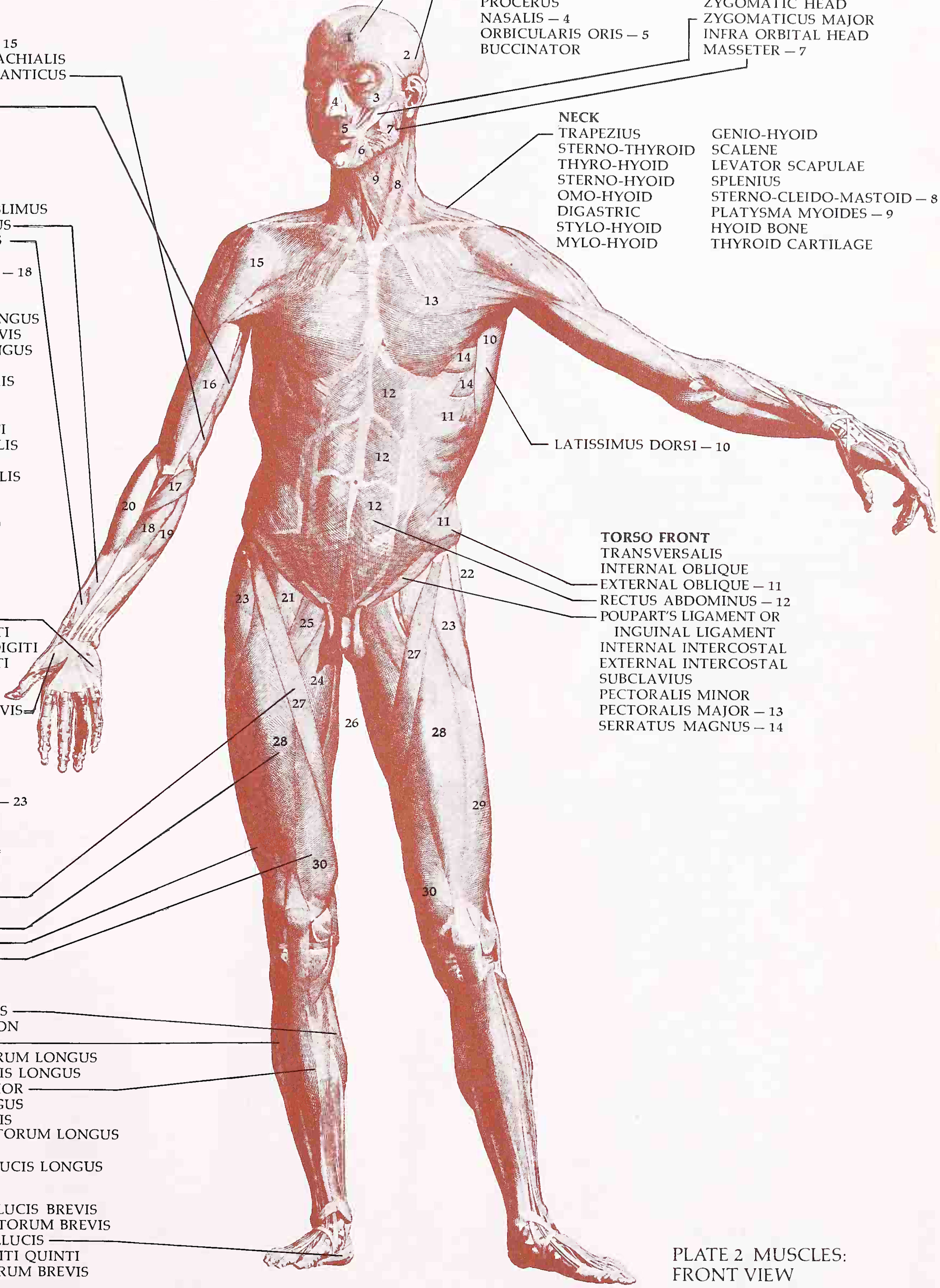
THORAX (RIB CAGE)
- STERNUM
  - MANUBRIUM – K, GLADIOLUS – L
  - XYPHOID PROCESS – M
- COSTAE (RIBS) – N
- COSTAL CARTILAGE

VERTEBRAE
- CERVICAL – O
- DORSAL
- LUMBAR – P
- (VERTEBRA)
  - BODY, SPINAL CANAL
  - ARTICULAR PROCESS
  - TRANSVERSE PROCESS
  - SPINOUS PROCESS

PELVIS
- OS INNOMINATUM – Q
  - ILIUM, ISCHIUM,
  - ACETABULUM
- PUBES – S, ILIAC CREST – R
- UPPER ILIAC SPINE
  - (FRONT & BACK)
- SACRUM – T
- COCCYX

LOWER EXTREMITY
- FEMUR
  - HEAD, NECK, GREAT TROCHANTER – U
  - INTERNAL CONDYLE – V, EXTERNAL CONDYLE – W
- PATELLA
- TIBIA
  - INTERNAL CONDYLE TUBEROSITY
  - EXTERNAL CONDYLE TUBEROSITY
  - INNER MALLEOLUS – X
- FIBULA
  - OUTER MALLEOLUS
- TARSUS (7 BONES)
  - TALUS (ASTRAGALUS) – Y
  - OS CALCIS (CALCANEUM) – Z
  - CUBOID
  - SCAPHOID
  - INTERNAL CUNEIFORM
  - MIDDLE CUNEIFORM
  - EXTERNAL CUNEIFORM
- METATARSALS
- PHALANGES

PLATE 1 SKELETON:
FRONT VIEW



HEAD

OCCIPITO – FRONTALIS – 1
TEMPORALIS – 2
ORBICULARIS OCULI – 3
CORRUGATOR SUPERCILII
LEVATOR PALPEBRAE
PROCERUS
NASALIS – 4
ORBICULARIS ORIS – 5
BUCCINATOR
RISORIUS
TRIANGULARIS – 6
QUADRATUS LABII INFERIORIS
MENTALIS
ANGULAR HEAD
ZYGOMATIC HEAD
ZYGOMATICUS MAJOR
INFRA ORBITAL HEAD
MASSETER – 7

UPPER ARM

DELTOID – 15
CORACO BRACHIALIS
BRACHIALIS ANTICUS
BICEPS – 16
TRICEPS
ANCONEUS

NECK

TRAPEZIUS
STERNO-THYROID
THYRO-HYOID
STERNO-HYOID
OMO-HYOID
DIGASTRIC
STYLO-HYOID
MYLO-HYOID
GENIO-HYOID
SCALENE
LEVATOR SCAPULAE
SPLENIUS
STERNO-CLEIDO-MASTOID – 8
PLATYSMA MYOIDES – 9
HYOID BONE
THYROID CARTILAGE

FOREARM

FLEXOR DIGITORUM SUBLIMUS
FLEXOR POLLICIS LONGUS
PRONATOR QUADRATUS
PRONATOR TERES – 17
FLEXOR CARPI RADIALIS – 18
PALMARIS LONGUS – 19
FLEXOR CARPI ULNARIS
ABDUCTOR POLLICIS LONGUS
EXTENSOR POLLICIS BREVIS
EXTENSOR POLLICIS LONGUS
EXTENSOR INDICIS
EXTENSOR CARPI ULNARIS
EXTENSOR COMMUNIS DIGITORUM
EXTENSOR MINIMI DIGITI
EXTENSOR CARPI RADIALIS BREVIS
EXTENSOR CARPI RADIALIS LONGUS
SUPINATOR LONGUS (BRACHIORADIALIS) – 20

LATISSIMUS DORSI – 10

HAND

LUMBRICALES
INTEROSSEI PALMARES
INTEROSSEI DORSALES I
PALMARIS BREVIS
ABDUCTOR MINIMI DIGITI
FLEXOR BREVIS MINIMI DIGITI
OPPONENS MINIMI DIGITI
OPPONENS POLLICIS
FLEXOR BREVIS POLLICIS
ABDUCTOR POLLICIS BREVIS

TORSO FRONT

TRANSVERSALIS
INTERNAL OBLIQUE
EXTERNAL OBLIQUE – 11
RECTUS ABDOMINUS – 12
POUPART'S LIGAMENT OR INGUINAL LIGAMENT
INTERNAL INTERCOSTAL
EXTERNAL INTERCOSTAL
SUBCLAVIUS
PECTORALIS MINOR
PECTORALIS MAJOR – 13
SERRATUS MAGNUS – 14

GLUTEAL AND THIGH

ILIOPSOAS – 21
GLUTEUS MEDIUS – 22
TENSOR FASCIAE LATAE – 23
ADDUCTOR MAGNUS
ADDUCTOR BREVIS
ADDUCTOR LONGUS – 24
PECTINIUS – 25
GRACILIS – 26
SARTORIUS – 27
QUADRICEPS FEMORIS
RECTUS FEMORIS – 28
VASTUS EXTERNUS – 29
VASTUS INTERNUS – 30
ILIO-TIBIAL BAND

LOWER LEG

GASTROCNEMIUS
ACHILLES TENDON
SOLEUS
FLEXOR DIGITORUM LONGUS
FLEXOR HALLUCIS LONGUS
TIBIALIS ANTERIOR
PERONEUS LONGUS
PERONEUS BREVIS
EXTENSOR DIGITORUM LONGUS (COMMUNIS)
EXTENSOR HALLUCIS LONGUS

FOOT

EXTENSOR HALLUCIS BREVIS
EXTENSOR DIGITORUM BREVIS
ABDUCTOR HALLUCIS
ABDUCTOR DIGITI QUINTI
FLEXOR DIGITORUM BREVIS

PLATE 2 MUSCLES: FRONT VIEW

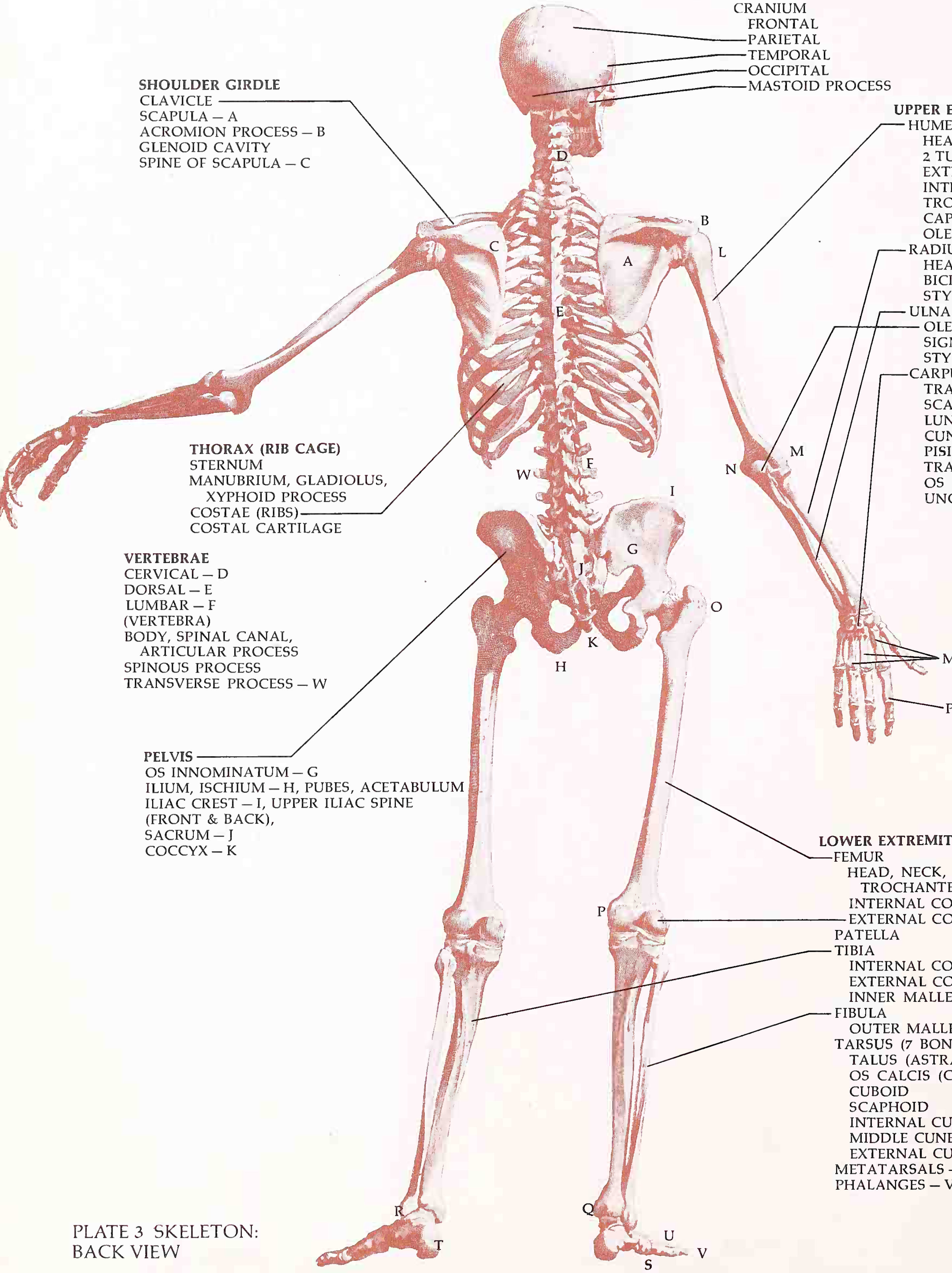
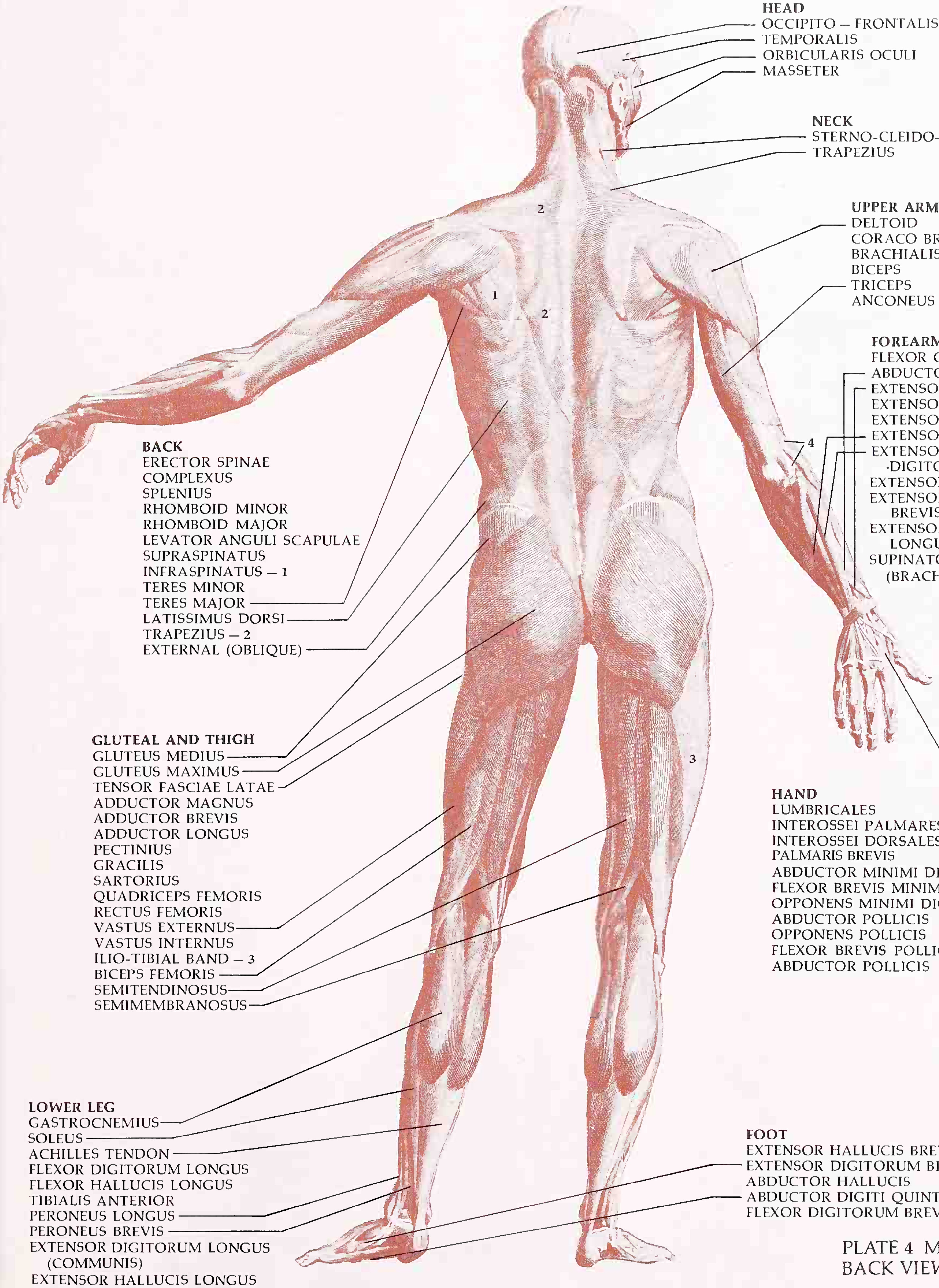

SKULL
CRANIUM
FRONTAL
PARIETAL
TEMPORAL
OCCIPITAL
MASTOID PROCESS
SHOULDER GIRDLE
CLAVICLE
SCAPULA – A
ACROMION PROCESS – B
GLENOID CAVITY
SPINE OF SCAPULA – C
UPPER EXTREMITY
HUMERUS
HEAD – NECK
2 TUBEROSITIES – L
EXTERNAL CONDYLE – M
INTERNAL CONDYLE – N
TROCHLEA
CAPITELLUM
OLECRANON CAVITY
RADIUS
HEAD
BICIPITAL TUBEROSITY
STYLOID PROCESS
ULNA
OLECRANON PROCESS
SIGMOID CAVITY
STYLOID PROCESS
CARPUS (8 BONES)
TRAPEZIUM
SCAPHOID
LUNATE
CUNEIFORM
PISIFORM
TRAPEZOID
OS MAGNUM
UNCIFORM
METACARPALS
PHALANGES
THORAX (RIB CAGE)
STERNUM
MANUBRIUM, GLADIOLUS,
XYPHOID PROCESS
COSTAE (RIBS)
COSTAL CARTILAGE
VERTEBRAE
CERVICAL – D
DORSAL – E
LUMBAR – F
(VERTEBRA)
BODY, SPINAL CANAL,
ARTICULAR PROCESS
SPINOUS PROCESS
TRANSVERSE PROCESS – W
PELVIS
OS INNOMINATUM – G
ILIUM, ISCHIUM – H, PUBES, ACETABULUM
ILIAC CREST – I, UPPER ILIAC SPINE
(FRONT & BACK),
SACRUM – J
COCCYX – K
LOWER EXTREMITY
FEMUR
HEAD, NECK, GREAT
TROCHANTER – O
INTERNAL CONDYLE – P
EXTERNAL CONDYLE
PATELLA
TIBIA
INTERNAL CONDYLE TUBEROSITY
EXTERNAL CONDYLE TUBEROSITY
INNER MALLEOLUS – Q
FIBULA
OUTER MALLEOLUS – R
TARSUS (7 BONES) – S
TALUS (ASTRAGALUS)
OS CALCIS (CALCANEUM) – T
CUBOID
SCAPHOID
INTERNAL CUNEIFORM
MIDDLE CUNEIFORM
EXTERNAL CUNEIFORM
METATARSALS – U
PHALANGES – V
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W

PLATE 3 SKELETON:
BACK VIEW



HEAD
OCCIPITO – FRONTALIS
TEMPORALIS
ORBICULARIS OCULI
MASSETER

NECK
STERNO-CLEIDO-MASTOID
TRAPEZIUS

UPPER ARM
DELTOID
CORACO BRACHIALIS
BRACHIALIS ANTICUS
BICEPS
TRICEPS
ANCONEUS

FOREARM
FLEXOR CARPI ULNARIS
ABDUCTOR POLLICIS LONGUS
EXTENSOR POLLICIS BREVIS
EXTENSOR POLLICIS LONGUS
EXTENSOR INDICIS
EXTENSOR CARPI ULNARIS
EXTENSOR COMMUNIS DIGITORUM
EXTENSOR MINIMI DIGITI
EXTENSOR CARPI RADIALIS BREVIS
EXTENSOR CARPI RADIALIS LONGUS – 4
SUPINATOR LONGUS (BRACHIORADIALIS) – 4

BACK
ERECTOR SPINAE
COMPLEXUS
SPLENIUS
RHOMBOID MINOR
RHOMBOID MAJOR
LEVATOR ANGULI SCAPULAE
SUPRASPINATUS
INFRASPINATUS – 1
TERES MINOR
TERES MAJOR
LATISSIMUS DORSI
TRAPEZIUS – 2
EXTERNAL (OBLIQUE)

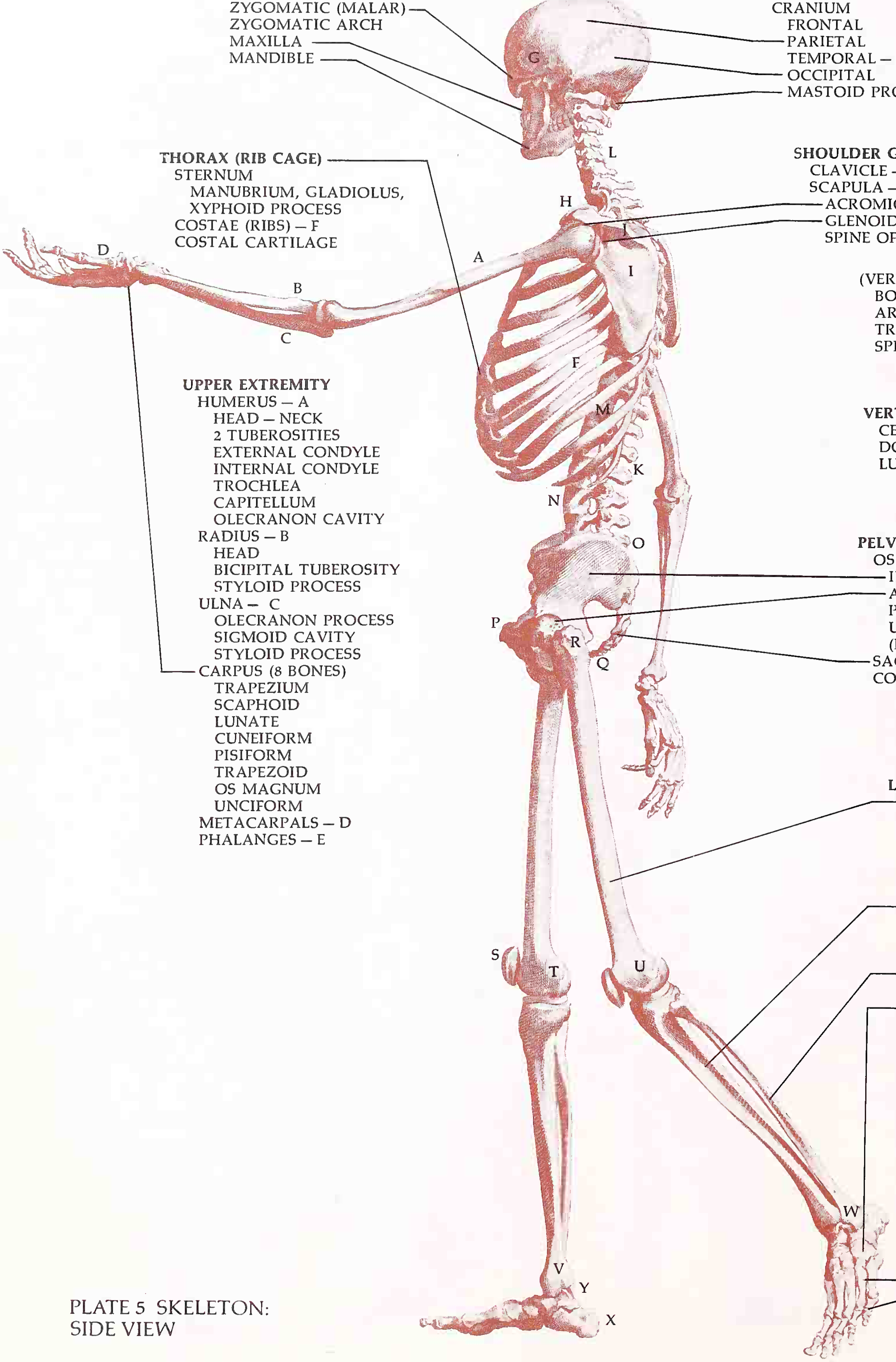
GLUTEAL AND THIGH
GLUTEUS MEDIUS
GLUTEUS MAXIMUS
TENSOR FASCIAE LATAE
ADDUCTOR MAGNUS
ADDUCTOR BREVIS
ADDUCTOR LONGUS
PECTINIUS
GRACILIS
SARTORIUS
QUADRICEPS FEMORIS
RECTUS FEMORIS
VASTUS EXTERNUS
VASTUS INTERNUS
ILIO-TIBIAL BAND – 3
BICEPS FEMORIS
SEMITENDINOSUS
SEMIMEMBRANOSUS

HAND
LUMBRICALES
INTEROSSEI PALMARES
INTEROSSEI DORSALES I
PALMARIS BREVIS
ABDUCTOR MINIMI DIGITI
FLEXOR BREVIS MINIMI DIGITI
OPPONENS MINIMI DIGITI
ABDUCTOR POLLICIS
OPPONENS POLLICIS
FLEXOR BREVIS POLLICIS
ABDUCTOR POLLICIS

LOWER LEG
GASTROCNEMIUS
SOLEUS
ACHILLES TENDON
FLEXOR DIGITORUM LONGUS
FLEXOR HALLUCIS LONGUS
TIBIALIS ANTERIOR
PERONEUS LONGUS
PERONEUS BREVIS
EXTENSOR DIGITORUM LONGUS (COMMUNIS)
EXTENSOR HALLUCIS LONGUS

FOOT
EXTENSOR HALLUCIS BREVIS
EXTENSOR DIGITORUM BREVIS
ABDUCTOR HALLUCIS
ABDUCTOR DIGITI QUINTI
FLEXOR DIGITORUM BREVIS

PLATE 4 MUSCLES:
BACK VIEW



FACE
ZYGOMATIC (MALAR)
ZYGOMATIC ARCH
MAXILLA
MANDIBLE

THORAX (RIB CAGE)
STERNUM
MANUBRIUM, GLADIOLUS,
XYPHOID PROCESS
COSTAE (RIBS) – F
COSTAL CARTILAGE

UPPER EXTREMITY
HUMERUS – A
HEAD – NECK
2 TUBEROSITIES
EXTERNAL CONDYLE
INTERNAL CONDYLE
TROCHLEA
CAPITELLUM
OLECRANON CAVITY
RADIUS – B
HEAD
BICIPITAL TUBEROSITY
STYLOID PROCESS
ULNA – C
OLECRANON PROCESS
SIGMOID CAVITY
STYLOID PROCESS
CARPUS (8 BONES)
TRAPEZIUM
SCAPHOID
LUNATE
CUNEIFORM
PISIFORM
TRAPEZOID
OS MAGNUM
UNCIFORM
METACARPALS – D
PHALANGES – E

SKULL
CRANIUM
FRONTAL
PARIETAL
TEMPORAL – G
OCCIPITAL
MASTOID PROCESS

SHOULDER GIRDLE
CLAVICLE – H
SCAPULA – I
ACROMION PROCESS
GLENOID CAVITY
SPINE OF SCAPULA – J

(VERTEBRA)
BODY, SPINAL CANAL,
ARTICULAR PROCESS,
TRANSVERSE PROCESS,
SPINOUS PROCESS – K

VERTEBRAE
CERVICAL – L
DORSAL – M
LUMBAR – N

PELVIS
OS INNOMINATUM
ILIUM, ISCHIUM,
ACETABULUM
PUBES – P, ILIAC CREST – O,
UPPER ILIAC SPINE
(FRONT & BACK)
SACRUM
COCCYX – Q

LOWER EXTREMITY
FEMUR
HEAD, NECK,
GREAT TROCHANTER – R,
INTERNAL CONDYLE – T,
EXTERNAL CONDYLE – U
PATELLA – S
TIBIA
INTERNAL CONDYLE TUBEROSITY
EXTERNAL CONDYLE TUBEROSITY
INNER MALLEOLUS – V
FIBULA
OUTER MALLEOLUS – W
TARSUS (7 BONES)
TALUS (ASTRAGALUS) – Y
OS CALCIS (CALCANEUM) – X
CUBOID
SCAPHOID
INTERNAL CUNEIFORM
MIDDLE CUNEIFORM
EXTERNAL CUNEIFORM

METATARSALS
PHALANGES

PLATE 5 SKELETON:
SIDE VIEW

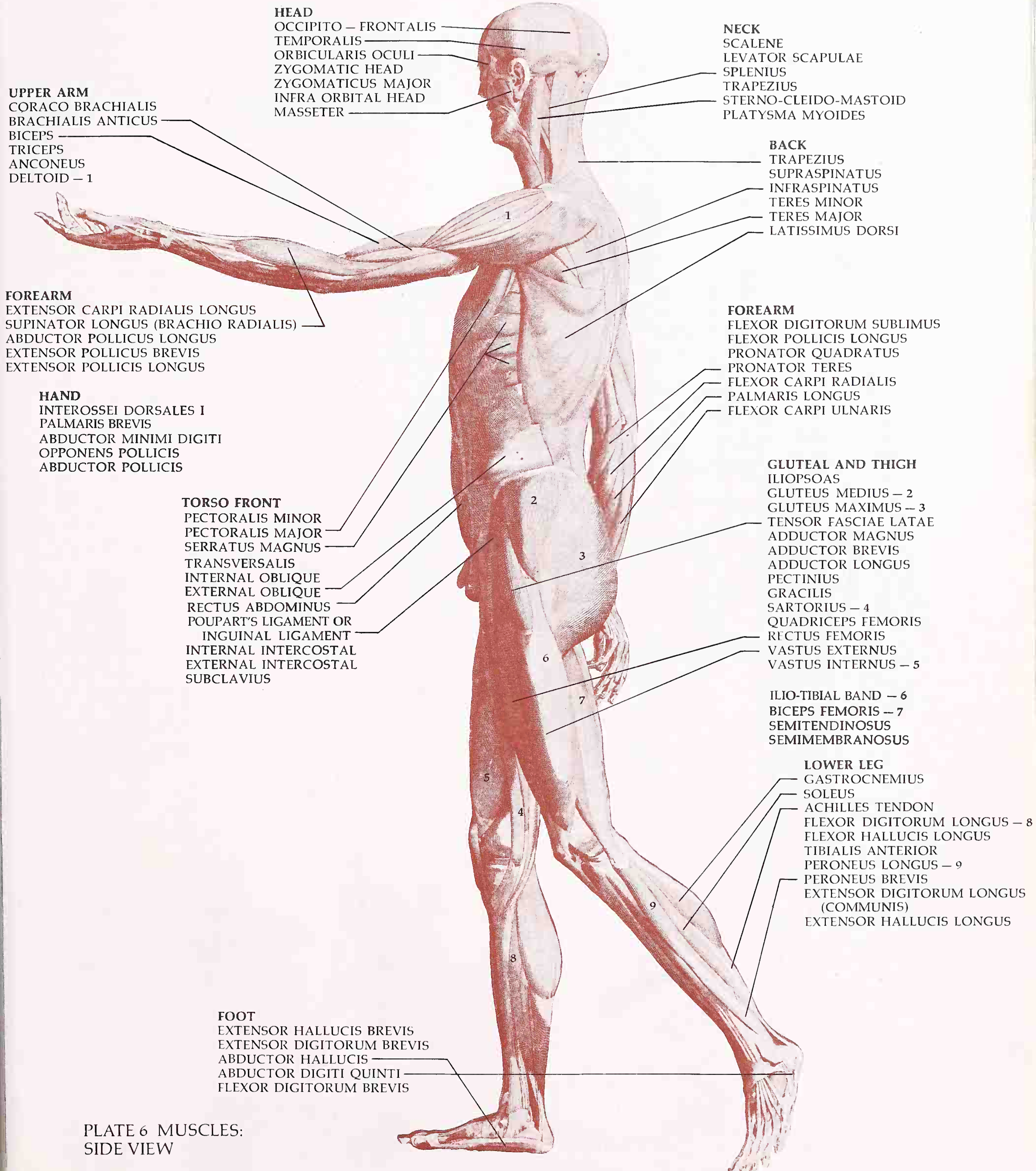
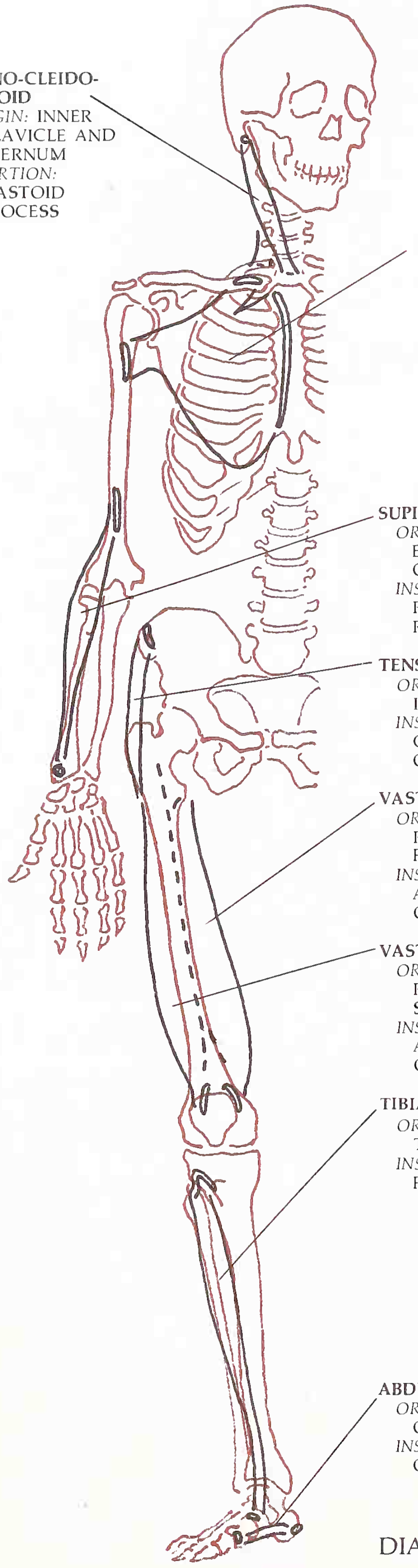

HEAD
OCCIPITO – FRONTALIS
TEMPORALIS
ORBICULARIS OCULI
ZYGOMATIC HEAD
ZYGOMATICUS MAJOR
INFRA ORBITAL HEAD
MASSETER
NECK
SCALENE
LEVATOR SCAPULAE
SPLENIUS
TRAPEZIUS
STERNO-CLEIDO-MASTOID
PLATYSMA MYOIDES
UPPER ARM
CORACO BRACHIALIS
BRACHIALIS ANTICUS
BICEPS
TRICEPS
ANCONEUS
DELTOID – 1
BACK
TRAPEZIUS
SUPRASPINATUS
INFRASPINATUS
TERES MINOR
TERES MAJOR
LATISSIMUS DORSI
FOREARM
EXTENSOR CARPI RADIALIS LONGUS
SUPINATOR LONGUS (BRACHIO RADIALIS)
ABDUCTOR POLLICUS LONGUS
EXTENSOR POLLICUS BREVIS
EXTENSOR POLLICIS LONGUS
FOREARM
FLEXOR DIGITORUM SUBLIMUS
FLEXOR POLLICIS LONGUS
PRONATOR QUADRATUS
PRONATOR TERES
FLEXOR CARPI RADIALIS
PALMARIS LONGUS
FLEXOR CARPI ULNARIS
HAND
INTEROSSEI DORSALES I
PALMARIS BREVIS
ABDUCTOR MINIMI DIGITI
OPPONENS POLLICIS
ABDUCTOR POLLICIS
GLUTEAL AND THIGH
ILIOPSOAS
GLUTEUS MEDIUS – 2
GLUTEUS MAXIMUS – 3
TENSOR FASCIAE LATAE
ADDUCTOR MAGNUS
ADDUCTOR BREVIS
ADDUCTOR LONGUS
PECTINIUS
GRACILIS
SARTORIUS – 4
QUADRICEPS FEMORIS
RECTUS FEMORIS
VASTUS EXTERNUS
VASTUS INTERNUS – 5
TORSO FRONT
PECTORALIS MINOR
PECTORALIS MAJOR
SERRATUS MAGNUS
TRANSVERSALIS
INTERNAL OBLIQUE
EXTERNAL OBLIQUE
RECTUS ABDOMINUS
POUPART'S LIGAMENT OR INGUINAL LIGAMENT
INTERNAL INTERCOSTAL
EXTERNAL INTERCOSTAL
SUBCLAVIUS
ILIO-TIBIAL BAND – 6
BICEPS FEMORIS – 7
SEMITENDINOSUS
SEMIMEMBRANOSUS
LOWER LEG
GASTROCNEMIUS
SOLEUS
ACHILLES TENDON
FLEXOR DIGITORUM LONGUS – 8
FLEXOR HALLUCIS LONGUS
TIBIALIS ANTERIOR
PERONEUS LONGUS – 9
PERONEUS BREVIS
EXTENSOR DIGITORUM LONGUS (COMMUNIS)
EXTENSOR HALLUCIS LONGUS
FOOT
EXTENSOR HALLUCIS BREVIS
EXTENSOR DIGITORUM BREVIS
ABDUCTOR HALLUCIS
ABDUCTOR DIGITI QUINTI
FLEXOR DIGITORUM BREVIS
1
2
3
4
5
6
7
8
9

PLATE 6 MUSCLES:
SIDE VIEW

CORRELATIVE SCHEME: ORIGIN AND INSERTION OF MAJOR SUPERFICIAL MUSCLES



STERNO-CLEIDO-MASTOID
ORIGIN: INNER CLAVICLE AND STERNUM
INSERTION: MASTOID PROCESS

PECTORALIS MAJOR
ORIGIN: INNER THIRD CLAVICLE AND ALL OF LENGTH OF STERNUM
INSERTION: BICIPITAL RIDGE OF HUMERUS

SUPINATOR LONGUS
ORIGIN: ABOVE EXTERNAL EPICONDYLE OF HUMERUS
INSERTION: STYLOID PROCESS OF RADIUS

TENSOR FASCIAE LATAE
ORIGIN: FRONT OF ILIAC CREST
INSERTION: BELOW GREAT TROCHANTER OF FEMUR

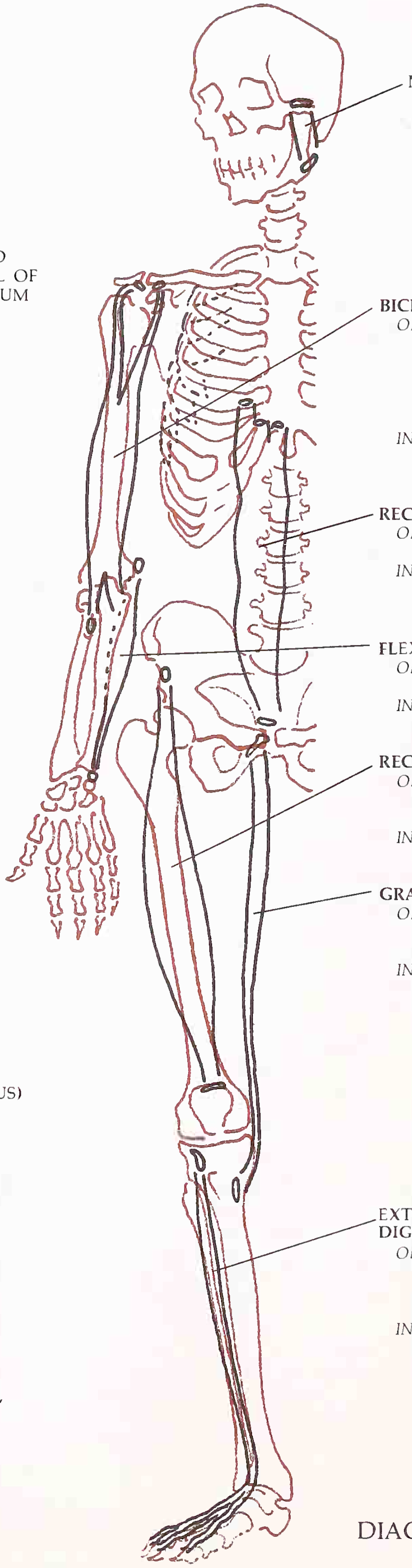
VASTUS INTERNUS
ORIGIN: INNER RIDGE REAR OF SHAFT OF FEMUR
INSERTION: INNER AND UPPER BORDER OF PATELLA

VASTUS EXTERNUS
ORIGIN: OUTER RIDGE, REAR SHAFT OF FEMUR
INSERTION: OUTER AND UPPER BORDER OF PATELLA

TIBIALIS ANTERIOR (ANTICUS)
ORIGIN: UPPER, OUTER TWO-THIRDS OF TIBIA
INSERTION: BASE OF FIRST METATARSAL

ABDUCTOR HALLUCIS
ORIGIN: INNER TUBERCLE, OS CALCIS
INSERTION: FIRST DIGIT OF GREAT TOE

DIAGRAM I



MASSETER
ORIGIN: ZYGOMATIC ARCH
INSERTION: RAMUS OF MANDIBLE

BICEPS
ORIGIN: SHORT HEAD—FROM CORACOID PROCESS OF SCAPULA
LONG HEAD—ABOVE GLENOID CAVITY OF SCAPULA
INSERTION: BICIPITAL TUBEROSITY OF RADIUS

RECTUS ABDOMINUS
ORIGIN: PUBIC SYMPHASIS
INSERTION: 5TH 6TH, 7TH COSTAL CARTILAGE

FLEXOR CARPI ULNARIS
ORIGIN: INTERNAL EPICONDYLE OF HUMERUS
INSERTION: PISIFORM BONE OF CARPUS

RECTUS FEMORIS
ORIGIN: ANTERIOR INFERIOR ILIAC SPINE OF PELVIS
INSERTION: UPPER BORDER OF PATELLA

GRACILIS
ORIGIN: LOWER SURFACE OF PUBIC BONE
INSERTION: UPPER INNER SURFACE OF TIBIA

EXTENSOR DIGITORUM LONGUS
ORIGIN: EXTERNAL TUBEROSITY OF TIBIA AND UPPER FIBULA
INSERTION: LAST TWO DIGITS OF FOUR SMALL TOES

DIAGRAM II

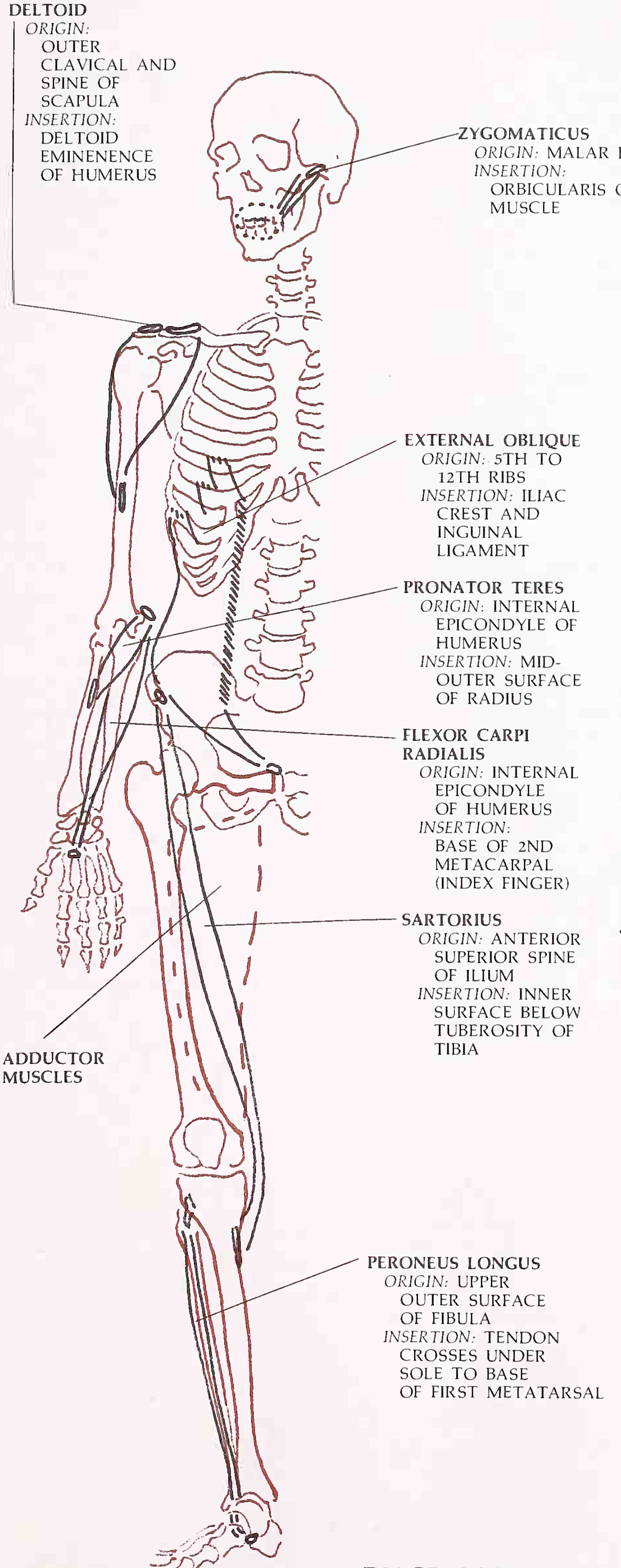

DELTOID
ORIGIN: OUTER CLAVICAL AND SPINE OF SCAPULA
INSERTION: DELTOID EMINENENCE OF HUMERUS
ZYGOMATICUS
ORIGIN: MALAR BONE
INSERTION: ORBICULARIS ORIS MUSCLE
EXTERNAL OBLIQUE
ORIGIN: 5TH TO 12TH RIBS
INSERTION: ILIAC CREST AND INGUINAL LIGAMENT
PRONATOR TERES
ORIGIN: INTERNAL EPICONDYLE OF HUMERUS
INSERTION: MID-OUTER SURFACE OF RADIUS
FLEXOR CARPI RADIALIS
ORIGIN: INTERNAL EPICONDYLE OF HUMERUS
INSERTION: BASE OF 2ND METACARPAL (INDEX FINGER)
SARTORIUS
ORIGIN: ANTERIOR SUPERIOR SPINE OF ILIUM
INSERTION: INNER SURFACE BELOW TUBEROSITY OF TIBIA
ADDUCTOR MUSCLES
PERONEUS LONGUS
ORIGIN: UPPER OUTER SURFACE OF FIBULA
INSERTION: TENDON CROSSES UNDER SOLE TO BASE OF FIRST METATARSAL

DIAGRAM III

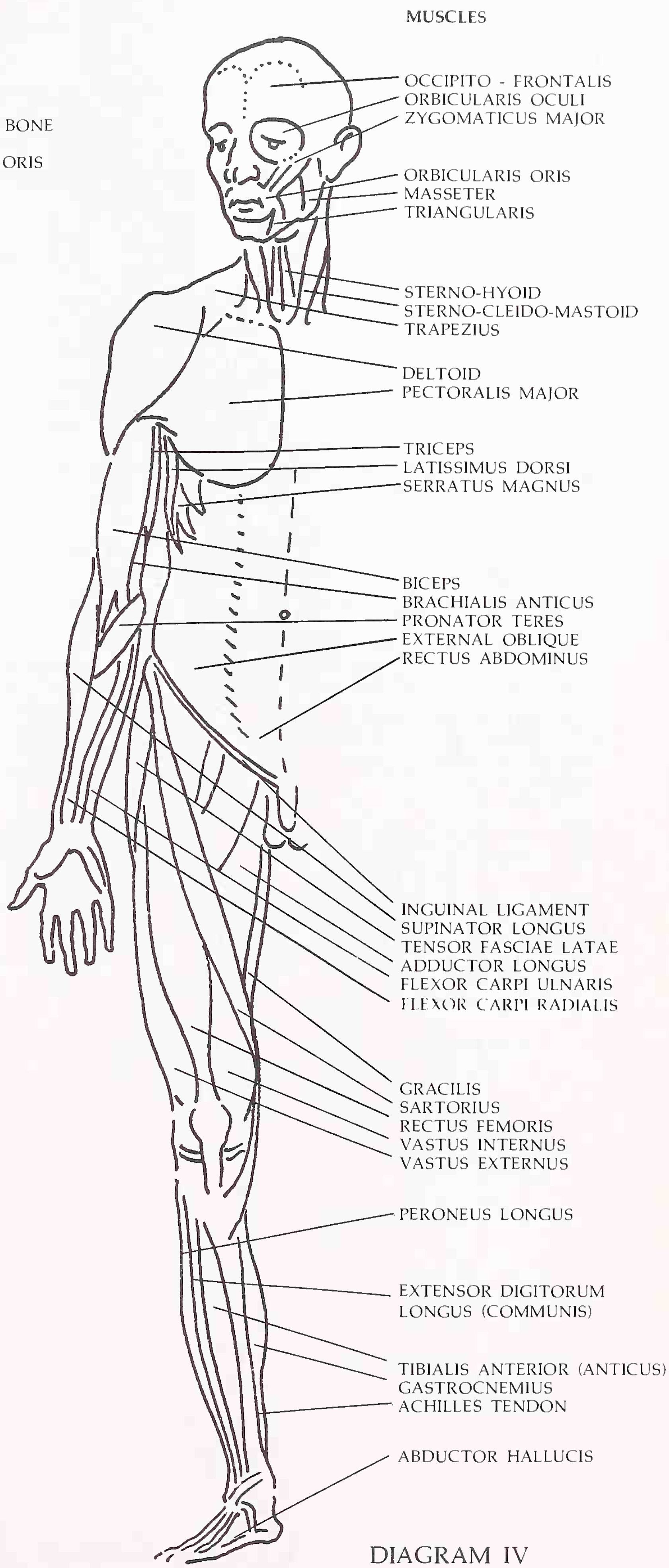
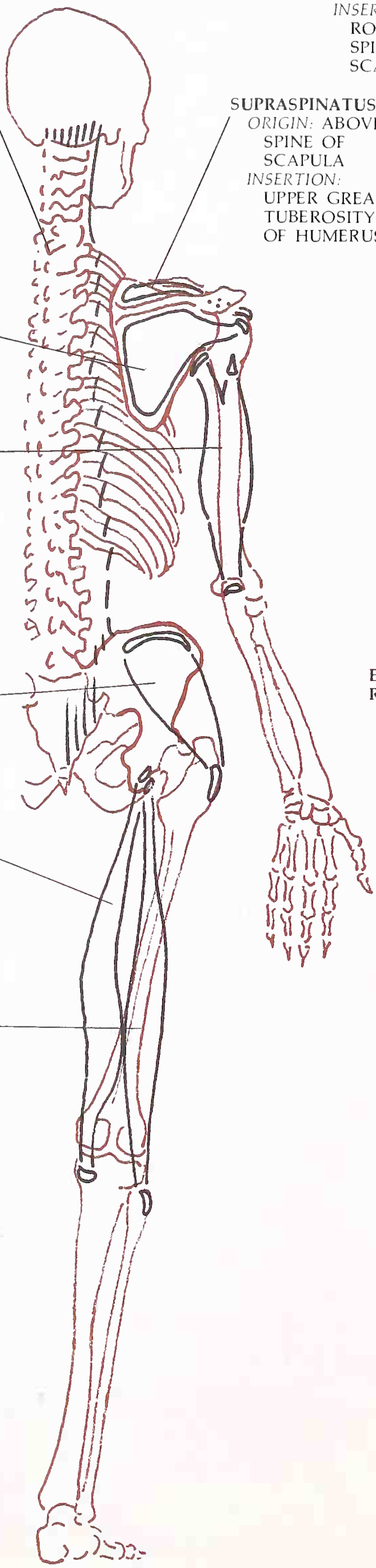

MUSCLES
OCCIPITO - FRONTALIS
ORBICULARIS OCULI
ZYGOMATICUS MAJOR
ORBICULARIS ORIS
MASSETER
TRIANGULARIS
STERNO-HYOID
STERNO-CLEIDO-MASTOID
TRAPEZIUS
DELTOID
PECTORALIS MAJOR
TRICEPS
LATISSIMUS DORSI
SERRATUS MAGNUS
BICEPS
BRACHIALIS ANTICUS
PRONATOR TERES
EXTERNAL OBLIQUE
RECTUS ABDOMINUS
INGUINAL LIGAMENT
SUPINATOR LONGUS
TENSOR FASCIAE LATAE
ADDUCTOR LONGUS
FLEXOR CARPI ULNARIS
FLEXOR CARPI RADIALIS
GRACILIS
SARTORIUS
RECTUS FEMORIS
VASTUS INTERNUS
VASTUS EXTERNUS
PERONEUS LONGUS
EXTENSOR DIGITORUM LONGUS (COMMUNIS)
TIBIALIS ANTERIOR (ANTICUS)
GASTROCNEMIUS
ACHILLES TENDON
ABDUCTOR HALLUCIS

DIAGRAM IV



ERECTOR SPINAE
ORIGIN: SACRUM
LUMBAR VERTEBRAE
LOWER THORACIC VERTEBRAE
INSERTION: REAR RIBS, OCCIPITAL BONE

SUPRASPINATUS
ORIGIN: ABOVE SPINE OF SCAPULA
INSERTION: UPPER GREAT TUBEROSITY OF HUMERUS

INFRASPINATUS
ORIGIN: SURFACE BELOW SPINE OF SCAPULA
INSERTION: GREAT TUBEROSITY OF HUMERUS

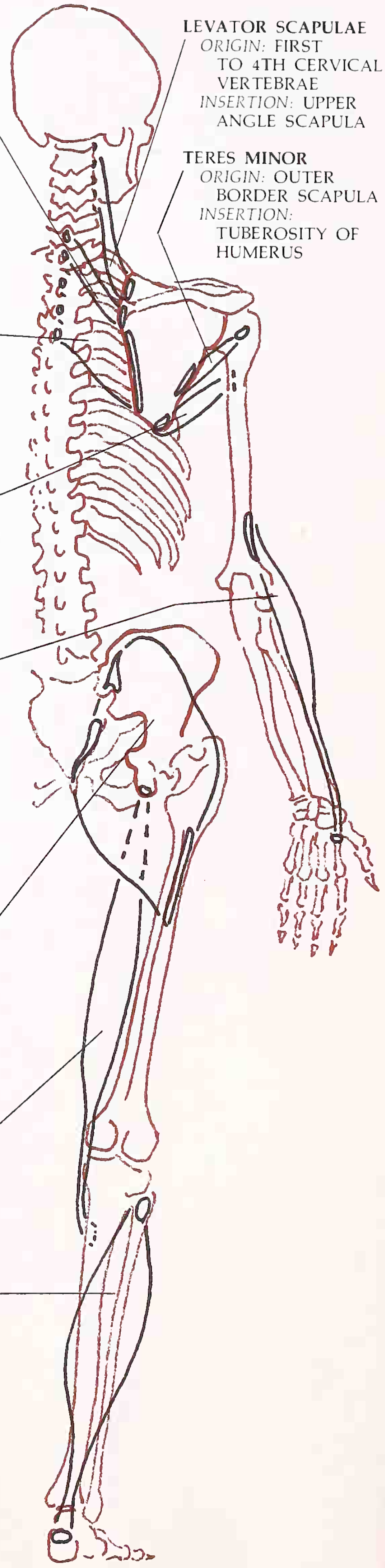
TRICEPS
ORIGIN: EXTERNAL HEAD UPPER REAR HUMERUS,
INTERNAL HEAD, LOWER REAR HUMERUS,
SCAPULAR (LONG) HEAD FROM BORDER, SCAPULA
INSERTION: OLECRANON PROCESS OF ULNA

GLUTEUS MEDIUS
ORIGIN: EXTERNAL SURFACE OF ILIUM
INSERTION: GREAT TROCHANTER

SEMIMEMBRANOSUS
ORIGIN: ISCHIAL TUBEROSITY
INSERTION: REAR TUBEROSITY TIBIA

BICEPS FEMORIS
ORIGIN: ISCHIAL TUBEROSITY
INSERTION: HEAD OF FIBULA AND TIBIA

DIAGRAM V



RHOMBOID MINOR
ORIGIN: 7TH CERVICAL AND FIRST THORACIC VERTEBRAE
INSERTION: ROOT OF SPINE OF SCAPULA

LEVATOR SCAPULAE
ORIGIN: FIRST TO 4TH CERVICAL VERTEBRAE
INSERTION: UPPER ANGLE SCAPULA

TERES MINOR
ORIGIN: OUTER BORDER SCAPULA
INSERTION: TUBEROSITY OF HUMERUS

RHOMBOID MAJOR
ORIGIN: 2ND TO 5TH THORACIC VERTEBRAE
INSERTION: INNER BORDER SCAPULA

TERES MAJOR
ORIGIN: LOWER SURFACE SCAPULA
INSERTION: INNER BICIPITAL RIDGE OF HUMERUS

EXTENSOR CARPI RADIALIS LONGUS
ORIGIN: LOWER EXTERNAL RIDGE OF HUMERUS
INSERTION: BASE OF SECOND METACARPAL

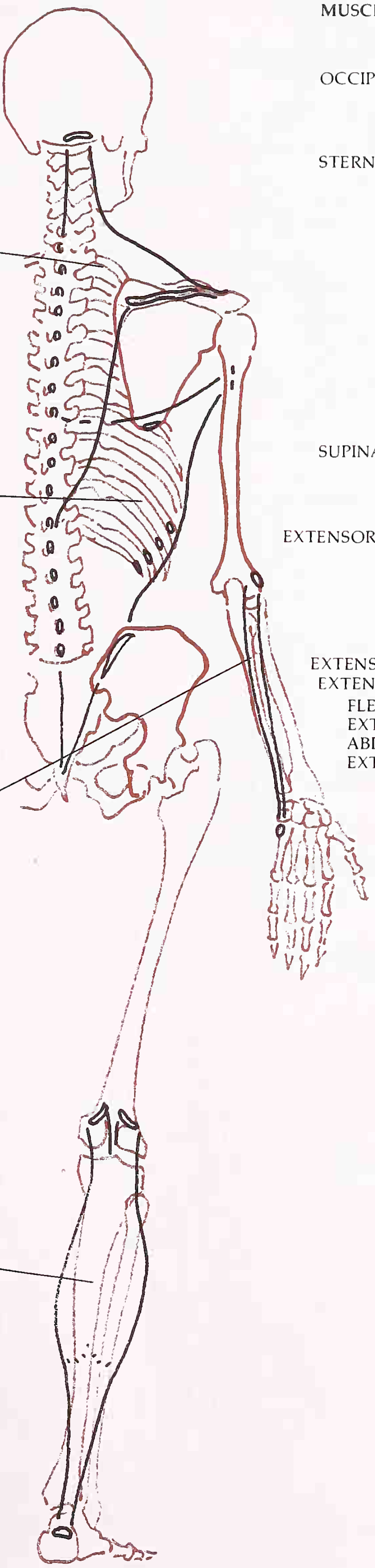
GLUTEUS MAXIMUS
ORIGIN: SACRUM AND REAR 3RD ILIAC CREST
INSERTION: UPPER REAR RIDGE FEMUR

SEMITENDINOSUS
ORIGIN: ISCHIAL TUBEROSITY
INSERTION: UPPER INNER SURFACE OF TIBIA

SOLEUS
ORIGIN: HEAD OF FIBULA AND TIBIA
INSERTION: OS CALCIS BONE

DIAGRAM VI

MUSCLES



TRAPEZIUS
ORIGIN:
OCCIPITAL BONE
7TH CERVICAL AND ALL 12 THORACIC VERTEBRAE
INSERTION:
OUTER THIRD OF CLAVICLE AND SPINE OF SCAPULA

LATISSIMUS DORSI
ORIGIN: LOWER 6 THORACIC VERTEBRAE, 5 LUMBAR-VERTEBRAE AND SACRUM
INSERTION:
BICIPITAL GROOVE OF HUMERUS

EXTENSOR CARPI ULNARIS
ORIGIN: EXTERNAL EPICONDYLE OF HUMERUS
INSERTION: BASE OF 5TH METACARPAL

GASTROCNEMIUS
ORIGIN: INTERNAL AND EXTERNAL CONDYLES OF FEMUR
INSERTION:
OS CALCIS-BONE

DIAGRAM VII

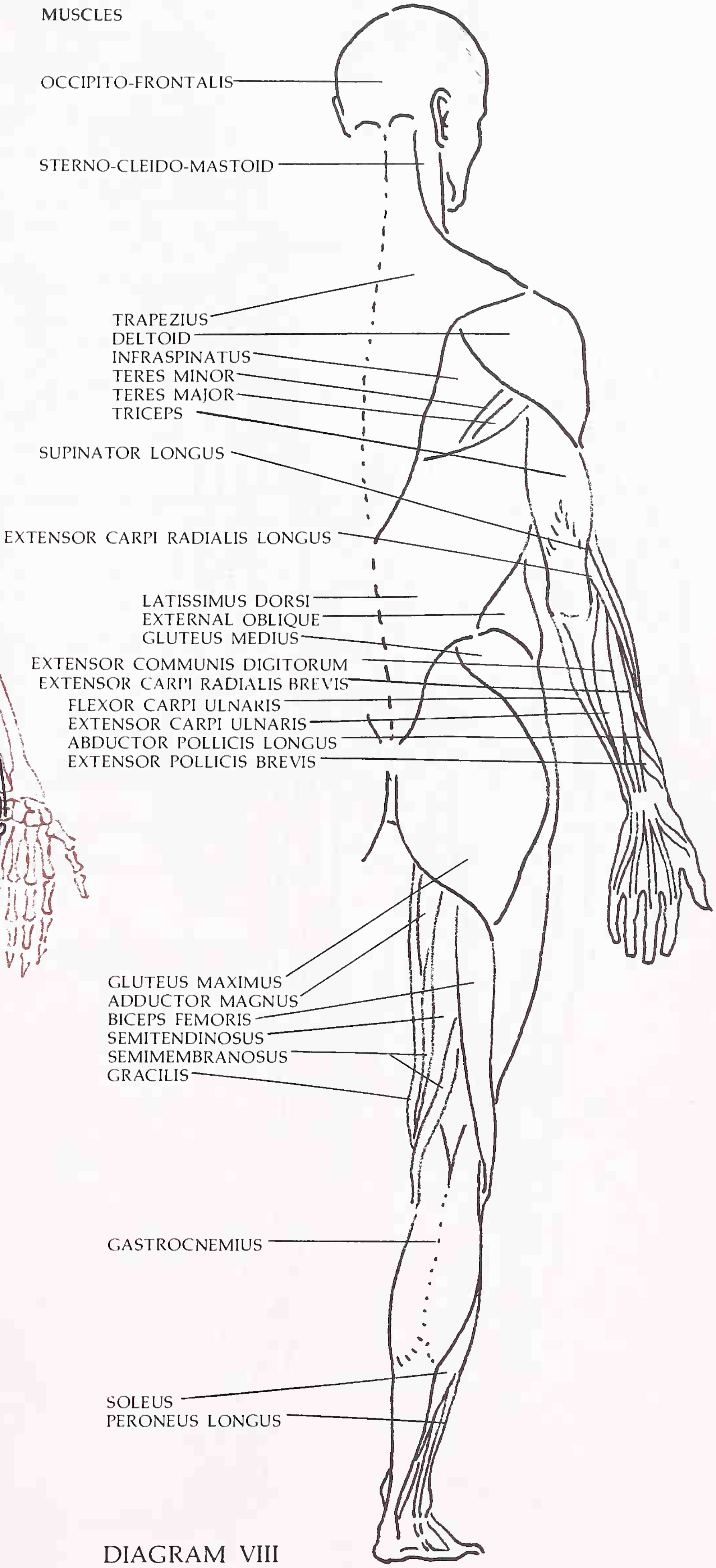
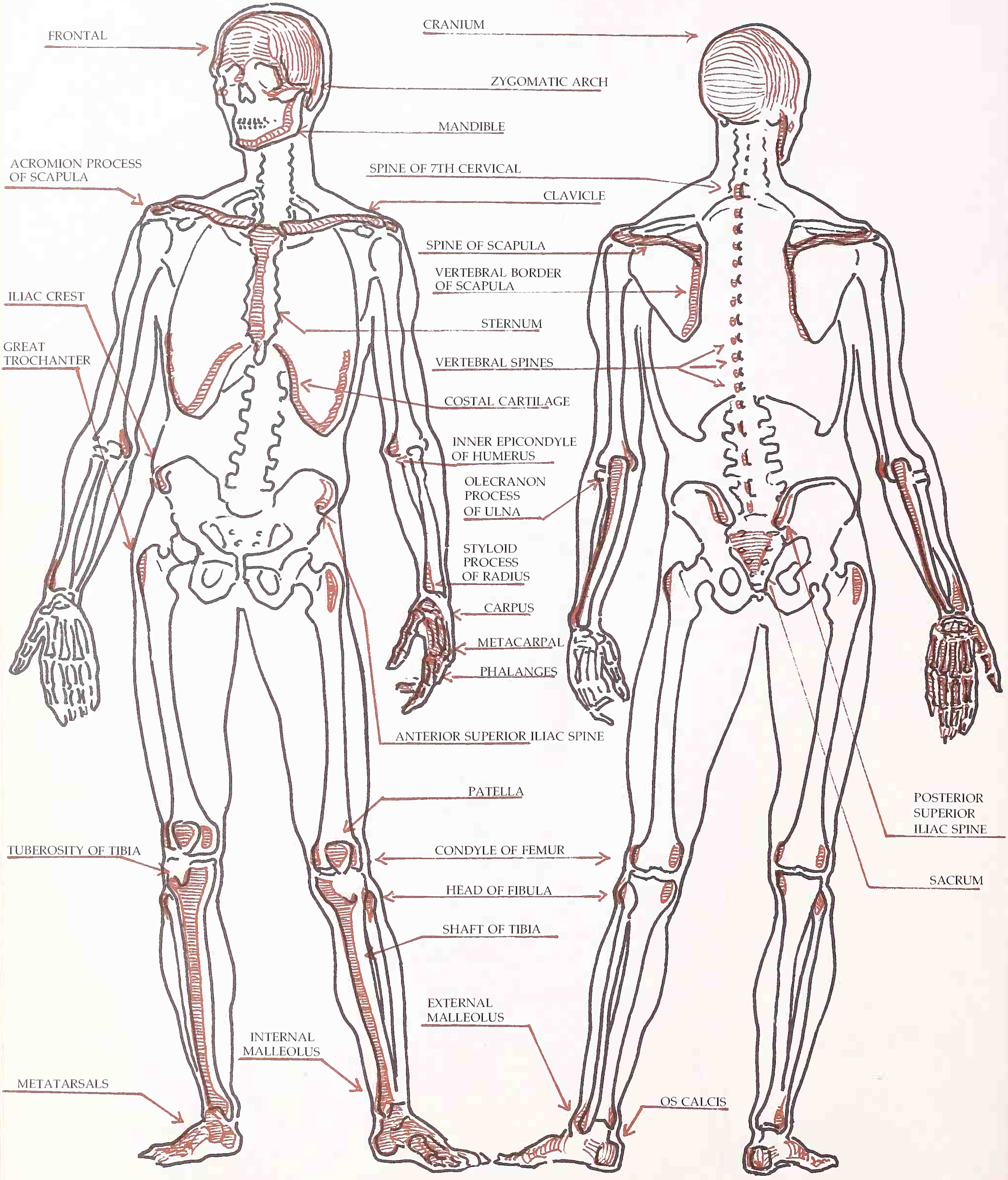
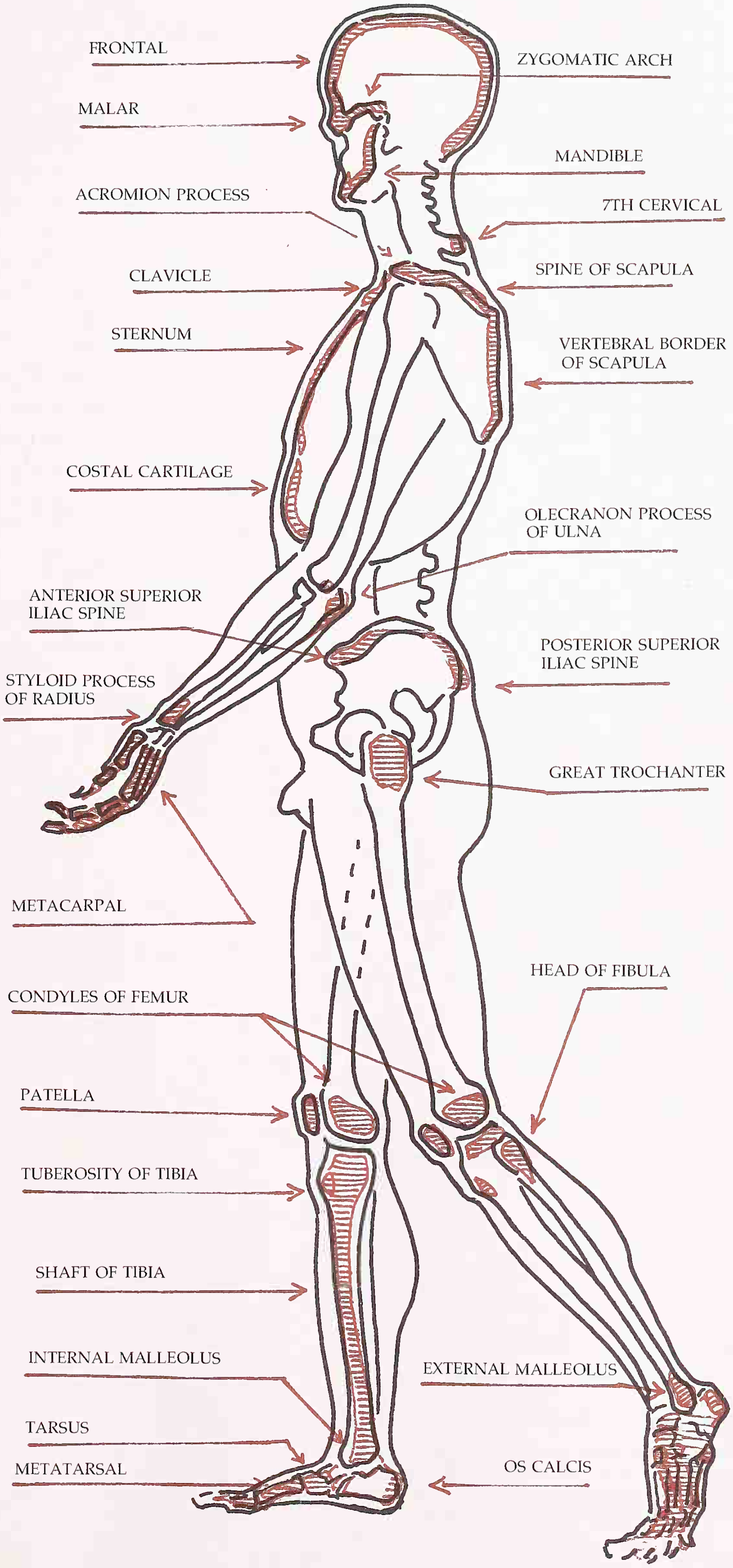

OCCIPITO-FRONTALIS
STERNO-CLEIDO-MASTOID
TRAPEZIUS
DELTOID
INFRASPINATUS
TERES MINOR
TERES MAJOR
TRICEPS
SUPINATOR LONGUS
EXTENSOR CARPI RADIALIS LONGUS
LATISSIMUS DORSI
EXTERNAL OBLIQUE
GLUTEUS MEDIUS
EXTENSOR COMMUNIS DIGITORUM
EXTENSOR CARPI RADIALIS BREVIS
FLEXOR CARPI ULNARIS
EXTENSOR CARPI ULNARIS
ABDUCTOR POLLICIS LONGUS
EXTENSOR POLLICIS BREVIS
GLUTEUS MAXIMUS
ADDUCTOR MAGNUS
BICEPS FEMORIS
SEMITENDINOSUS
SEMIMEMBRANOSUS
GRACILIS
GASTROCNEMIUS
SOLEUS
PERONEUS LONGUS

DIAGRAM VIII

SUBCUTANEOUS SKELETAL INFLUENCE ON SURFACE FORM

10-12

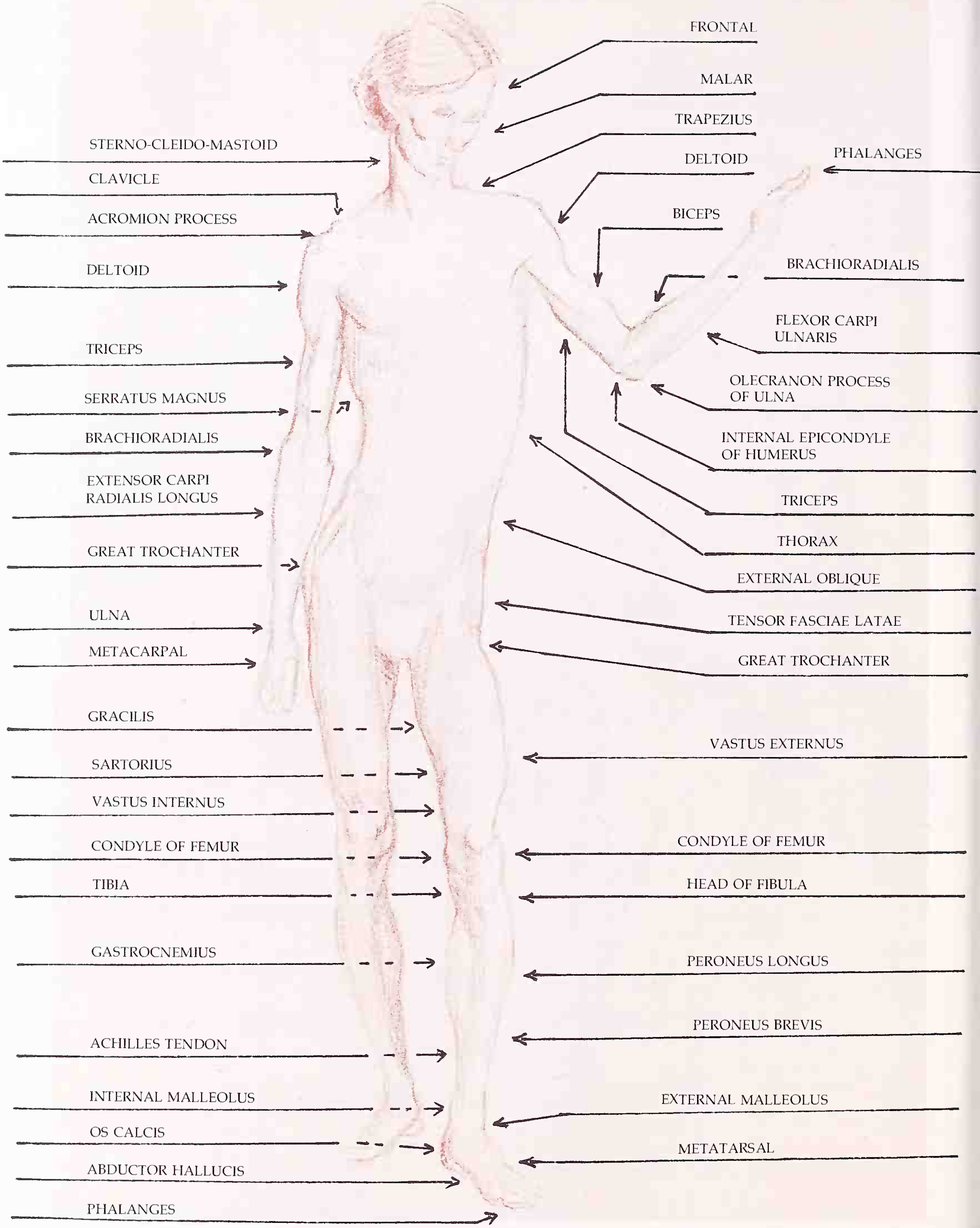

FRONTAL
CRANIUM
ZYGOMATIC ARCH
MANDIBLE
ACROMION PROCESS OF SCAPULA
SPINE OF 7TH CERVICAL
CLAVICLE
SPINE OF SCAPULA
VERTEBRAL BORDER OF SCAPULA
ILIAC CREST
STERNUM
GREAT TROCHANTER
VERTEBRAL SPINES
COSTAL CARTILAGE
INNER EPICONDYLE OF HUMERUS
OLECRANON PROCESS OF ULNA
STYLOID PROCESS OF RADIUS
CARPUS
METACARPAL
PHALANGES
ANTERIOR SUPERIOR ILIAC SPINE
PATELLA
POSTERIOR SUPERIOR ILIAC SPINE
TUBEROSITY OF TIBIA
CONDYLE OF FEMUR
SACRUM
HEAD OF FIBULA
SHAFT OF TIBIA
EXTERNAL MALLEOLUS
INTERNAL MALLEOLUS
METATARSALS
OS CALCIS


FRONTAL
MALAR
ACROMION PROCESS
CLAVICLE
STERNUM
COSTAL CARTILAGE
ANTERIOR SUPERIOR ILIAC SPINE
STYLOID PROCESS OF RADIUS
METACARPAL
CONDYLES OF FEMUR
PATELLA
TUBEROSITY OF TIBIA
SHAFT OF TIBIA
INTERNAL MALLEOLUS
TARSUS
METATARSAL
ZYGOMATIC ARCH
MANDIBLE
7TH CERVICAL
SPINE OF SCAPULA
VERTEBRAL BORDER OF SCAPULA
OLECRANON PROCESS OF ULNA
POSTERIOR SUPERIOR ILIAC SPINE
GREAT TROCHANTER
HEAD OF FIBULA
EXTERNAL MALLEOLUS
OS CALCIS

10-12 and 10-13

Subcutaneous Skeletal Influence on Surface Form.

Shaded areas indicate the parts of bone and cartilage sufficiently near the skin surface to directly affect the external form.


STERNO-CLEIDO-MASTOID
CLAVICLE
ACROMION PROCESS
DELTOID
TRICEPS
SERRATUS MAGNUS
BRACHIORADIALIS
EXTENSOR CARPI RADIALIS LONGUS
GREAT TROCHANTER
ULNA
METACARPAL
GRACILIS
SARTORIUS
VASTUS INTERNUS
CONDYLE OF FEMUR
TIBIA
GASTROCNEMIUS
ACHILLES TENDON
INTERNAL MALLEOLUS
OS CALCIS
ABDUCTOR HALLUCIS
PHALANGES
FRONTAL
MALAR
TRAPEZIUS
DELTOID
PHALANGES
BICEPS
BRACHIORADIALIS
FLEXOR CARPI ULNARIS
OLECRANON PROCESS OF ULNA
INTERNAL EPICONDYLE OF HUMERUS
TRICEPS
THORAX
EXTERNAL OBLIQUE
TENSOR FASCIAE LATAE
GREAT TROCHANTER
VASTUS EXTERNUS
CONDYLE OF FEMUR
HEAD OF FIBULA
PERONEUS LONGUS
PERONEUS BREVIS
EXTERNAL MALLEOLUS
METATARSAL

10-14

Anatomy of a Contour by the author. (Photograph by Iso Papo.)

This study, with minimal inner modeling, focuses on firm bone and muscle contour definition. Purged of inner surface development, the chaste image of a contour drawing may appear anatomically anonymous. But each bulge and indentation has a distinct anatomical identity. An informed contour line will illustrate muscular cross tensions and skeletal firmness.

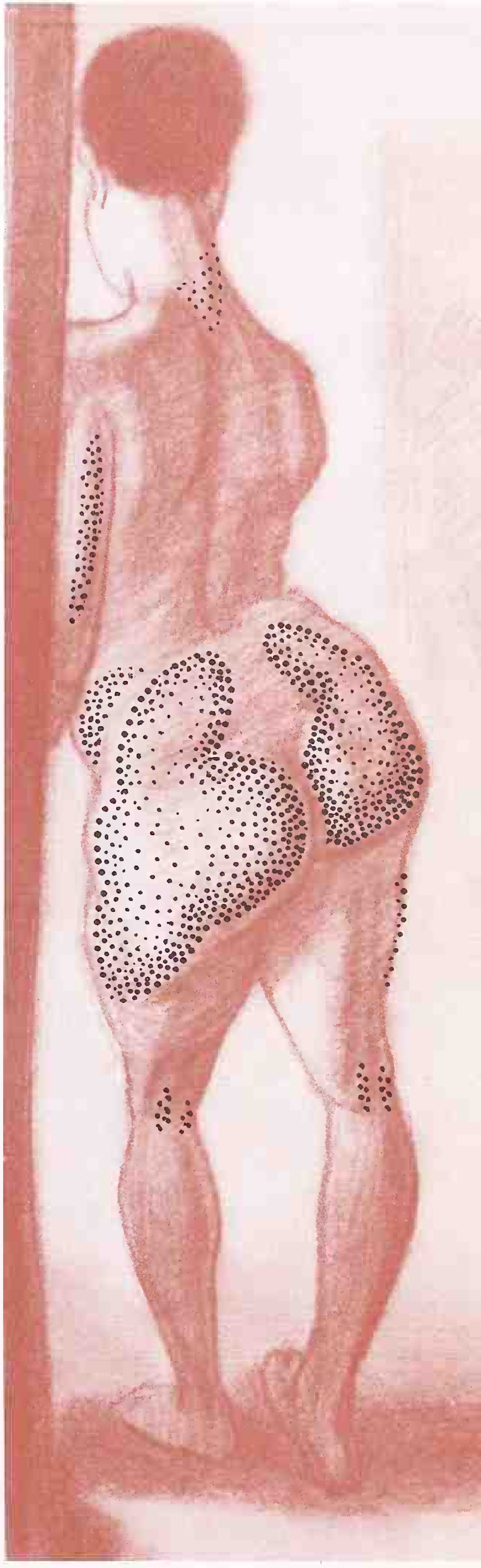
FAT

The location of surface fat can be discussed in only the most general terms. In the very obese, fat can completely disguise muscle structure and, to a great extent, skeletal form as well. However, the accumulation of fat between muscle and skin does follow a pattern and it may help to diagram its formation in relation to bone and muscle. Fatty tissue develops generally in the shaded areas indicated in illustrations 10-15 and 10-16. The transition from fat to muscle is so gradual that it will often present the figure as simple, unified volumes. Knowledge of muscle tension and bone structure should help to identify subtle direction in a form, no matter how well disguised by fat.

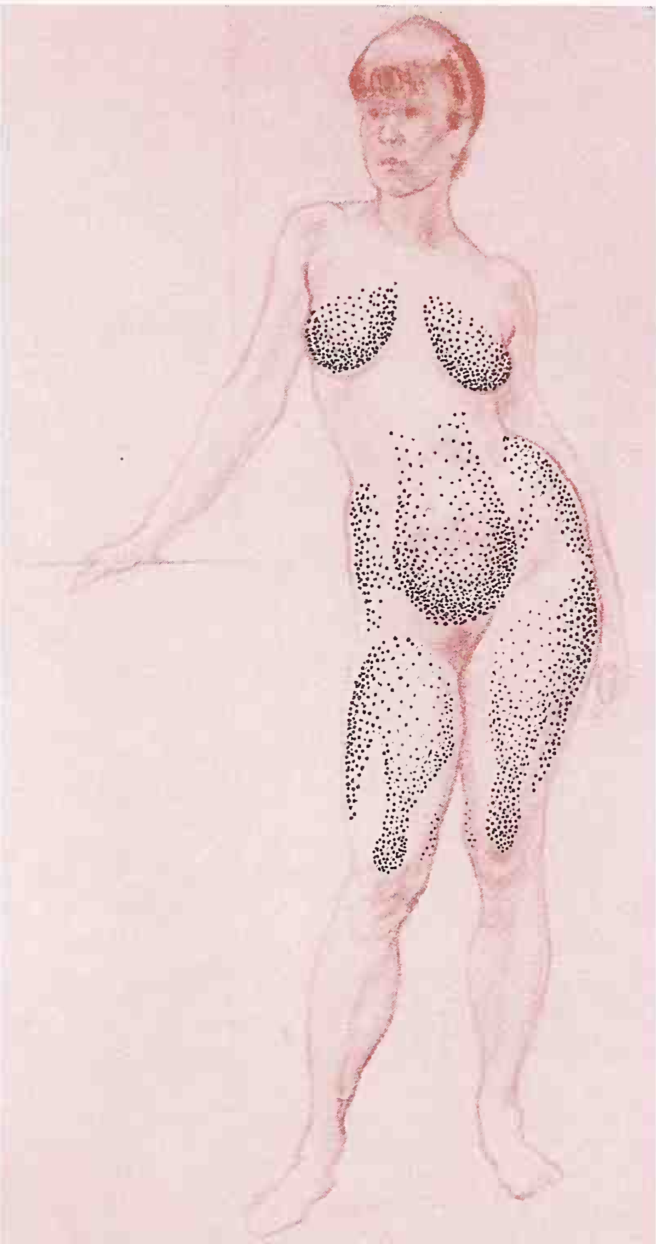
In the female figure fat may be found in the breasts, abdomen, hips, thighs, buttocks, back of the neck, rear of upper arms, cheeks, and the popliteal space (behind knee articulation). Fat is more prevalent in the female figure and as connective tissue provides a subtle unity and continuity of form.

An abundance of fat, however, may be divisive where it emphasizes furrows and wrinkles. The transverse lines within the rectus abdominus muscle, for example, may form deep creases and appear to cut the figure in half at the navel.

In the male, the development of muscle is greater and more clearly marked. Fat, when it develops, is mainly located in the buttocks, flank pad, and abdomen.



10-16



10-15

10-15

Location of Fatty Tissue: Front View by the author. (Photograph by Ronald Lubin.)

10-16

Location of Fatty Tissue: Back View by the author. (Photograph by Kalman Zabarsky.)

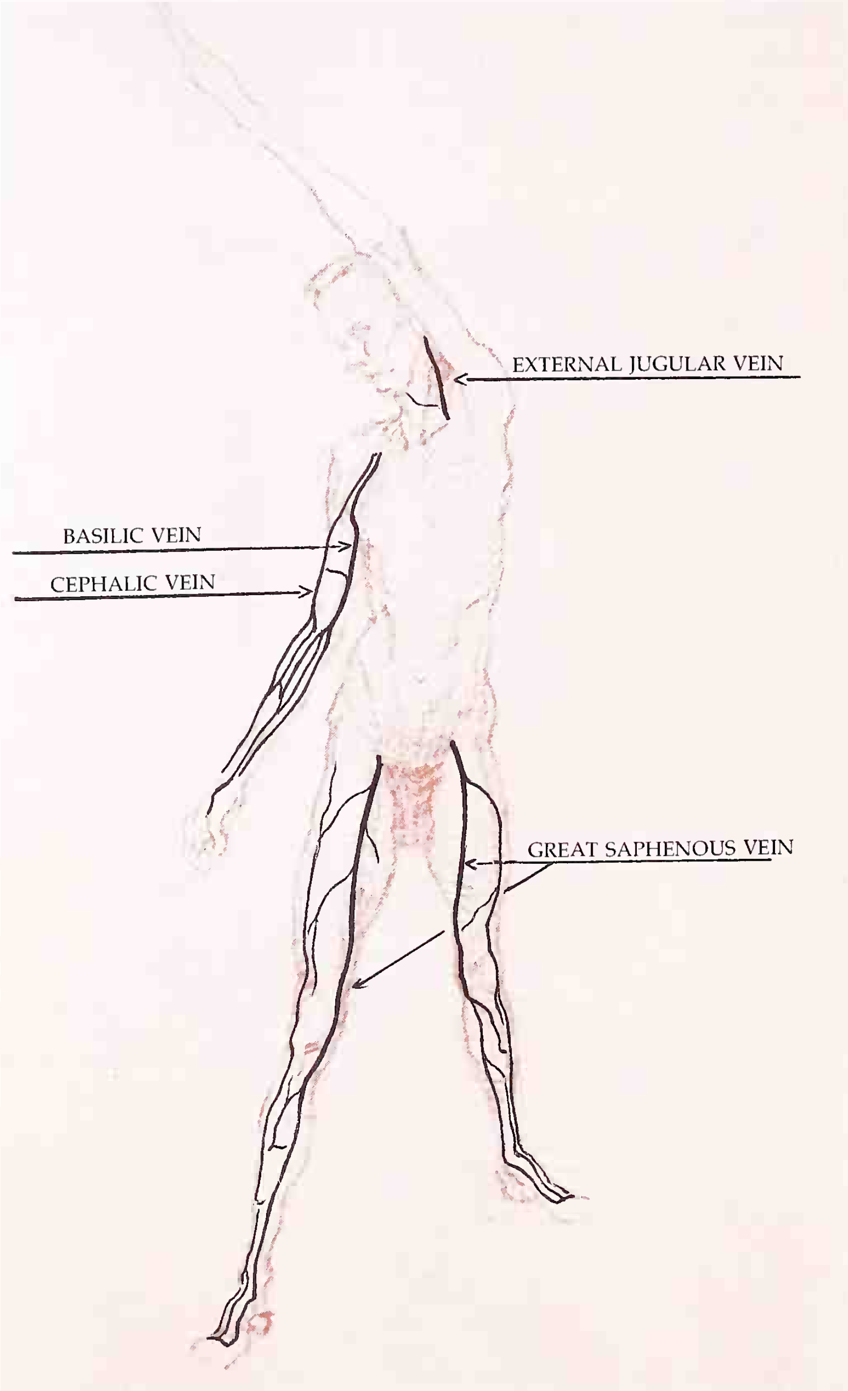
VEINS, BODY HAIR, AND SKIN WRINKLES

Superficial veins, those close to the skin surface, are visible in the neck, arms, and legs. (Veins in the torso are deep and remain hidden.) Part of the circulatory system, veins are bluish in color.

The complex network of the vascular system may corrugate and confuse many of the larger surfaces in the figure. Veins are particularly evident in the elderly. To communicate age adequately, it may be useful to include pronounced indications of veins in the hands, neck, and lower legs.

Veins, however, should be understood to inhabit larger, broader surfaces. The great danger is to give them an emphasis that destroys the unity of the underlying form. Wrinkles and body hair on the chest, arms, and legs must also be cautiously integrated within the large relationships.

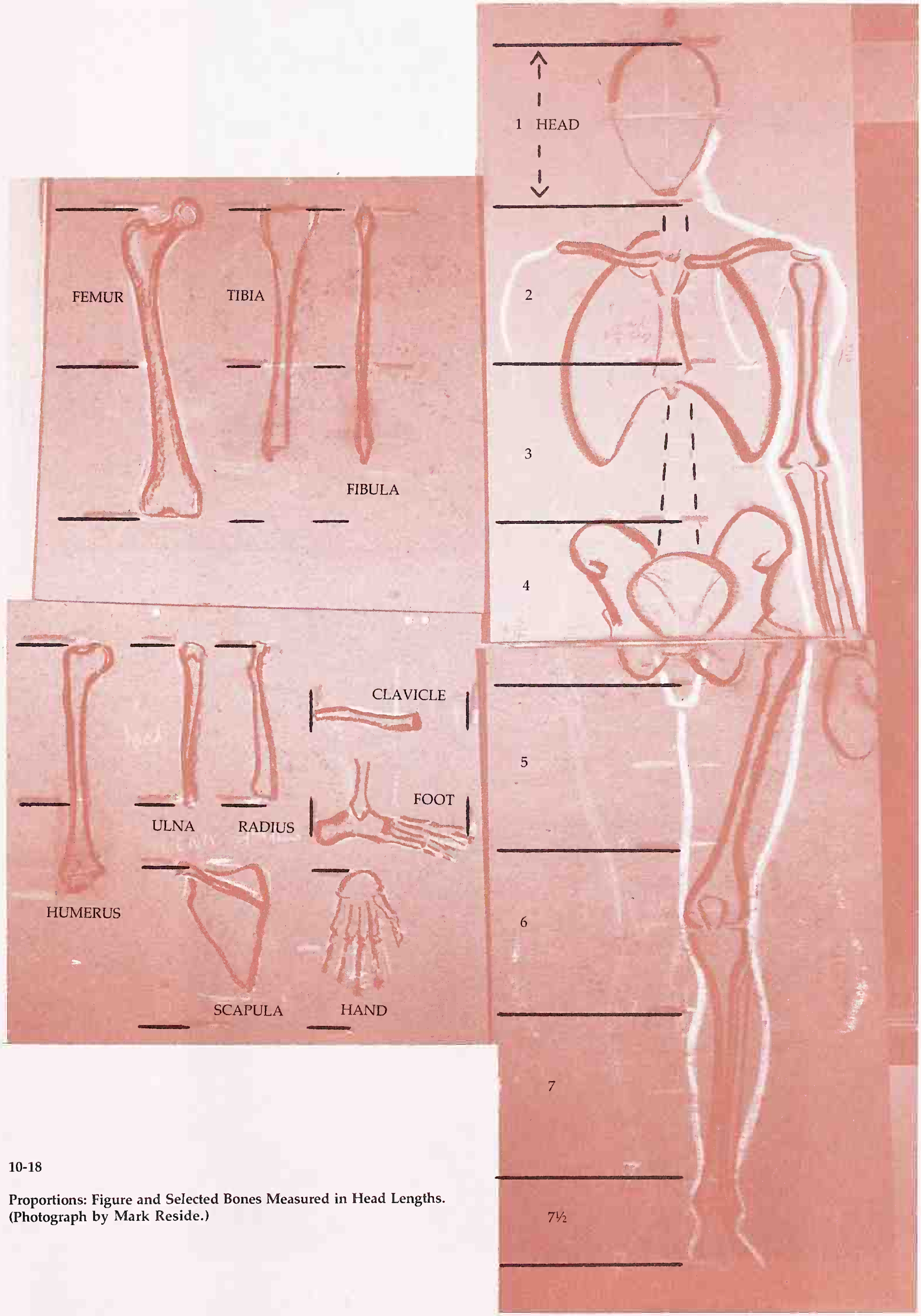
10-17



10-17

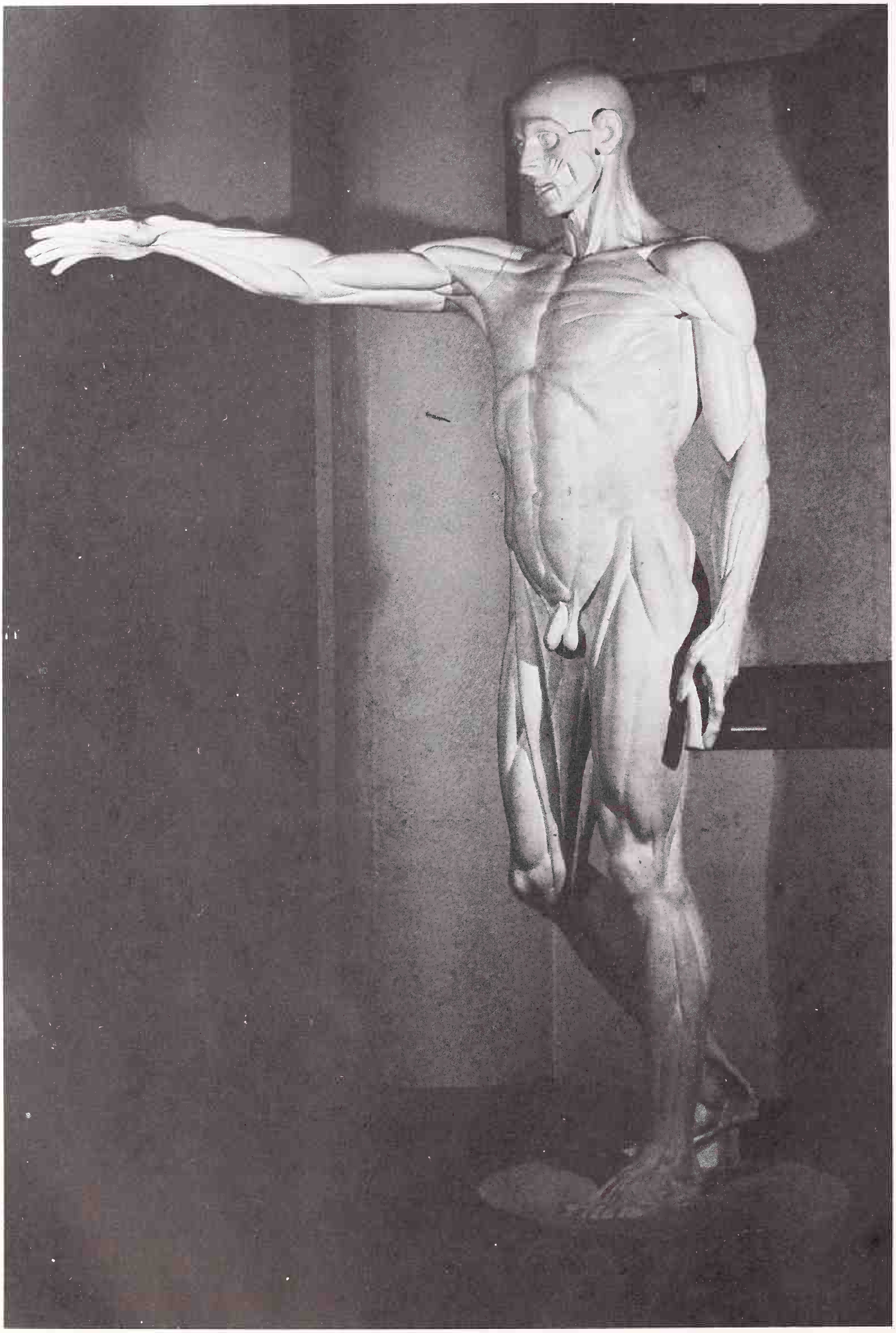
Study of Major Superficial Veins by the author. (Photograph by Kalman Zabarsky.)

10-18


1 HEAD
2
3
4
5
6
7
7½
FEMUR
TIBIA
FIBULA
CLAVICLE
FOOT
ULNA
RADIUS
HUMERUS
SCAPULA
HAND

10-18

Proportions: Figure and Selected Bones Measured in Head Lengths. (Photograph by Mark Reside.)



10-19

Houdon's Ecorché. New cast by Nedo Cassettari. (Photograph by Mark Reside.)
Life-size muscle figure by the great French eighteenth-century portrait sculptor.

APPENDIX: SOURCES OF SUPPLY

Visual aids recommended in the text may be obtained from the firms and institutions listed. Catalogs and price lists are usually available upon request (some for a small fee).

Local firms that may provide visual aids are hospital supply houses, medical bookstores (charts), school suppliers, and athletic supply firms. Your local art supplier may have additional suggestions. Some large pharmaceutical companies produce anatomical models, diagrams, and charts for distribution to the medical profession (usually obtainable only through a physician).

An inexpensive source of the portrait head for study of features and frontal head structure are the life masks produced by university sculpture departments to illustrate casting technique. Replicas of antique sculpture sold in museum shops and art supply stores can also be used.

The renowned Houdon Ecorché (life-size plaster muscle figure) is not available commercially to my knowledge. A 28-inch replica, however, is available from Giust Gallery or Sculpture House.

Slides of master drawings, paintings, and sculpture can be obtained from museum slide collections. The anatomical drawings of Leonardo Da Vinci and the drawings and sculpture of Michelangelo are good choices, as are the works of Bronzino, Rodin, Bernini, Vittoria Da Bologna, Raphael, Pontormo, Vesalius, and Albinus, and Greek and Roman sculpture.

SKELETONS AND LARGE MUSCLE CHARTS

Anatomical Chart Co.
1622 West Morse Avenue
Chicago, Illinois 60626
(312) 764-7171

Carolina Biological Supply Co.
Burlington, NC 27215
(800) 334-5551

CASS (Canadian Anatomical Specimen Supply)
308 Harbord Street
Toronto, Ontario, Canada M6G1G8
(416) 532-8578

Clay-Adams
Division of Becton-Dickinson & Company
Parsipanny, NJ 07054

"Dial A Bone—Dial A Muscle"
Phil Steele
Rocky Mountain School of Art
1441 Ogden Street
Denver, CO 80218
Compact rotating nomenclature diagrams

Medical Plastics Laboratories Inc.
P.O. Box 38
Gatesville, TX 76528
(817) 865-7221

Renewal Educational Toys
"The Visible Head"
Renewal Products Inc.
Mineola, NY 11501
Produces a life-size faithful replica in plastic of the human skull. Requires assembly. Reasonably priced.

MUSCLE CASTS

Giust Gallery
1920 Washington Street
Roxbury, MA 02119 02118 $5.00 FOR CAT
(617) 445-3800
Faithful replicas of classical sculpture. Has anatomical cast of good quality.

Orlandi Statuary Inc.
459 North Milwaukee Avenue X
Chicago, IL 60016
(312) 666-1836

Sculpture House, Inc.
38 East 30th Street -N.J.
New York, NY 10016 609-466-2986 NO ANS.
(212) 679-7474
Anatomical casts of the full figure and a variety of parts, arm, leg, and head and individual features.

FILMS

Films on the Skeleton

Human Body: The Skeleton
running time: 10 minutes—1953
made by Coronet films—black and white

The Skeleton (second edition)
running time: 17 minutes—1980
made by EBEC films—color

Leonardo and His Art
running time: 14 minutes—1957
made by Coronet films—color

Other Films on Leonardo are:
Leonardo Da Vinci
running time: 25 minutes
made by EBEC films

Leonardo Da Vinci, First Man of the Renaissance
running time: 10 minutes
made by Disney Films

Films on the Muscles

Human Body: Muscular System
running time: 14 minutes—1962
made by Coronet films—color

Muscles and Bones of the Body
running time: 11 minutes—1960
made by Coronet films—color

Tissues of the Human Body
running time: 17 minutes—1963
made by Churchill films—color

Michelangelo and His Art
running time: 16 minutes—1963
made by Coronet films—color

Another film on Michelangelo is:

Michelangelo
running time: 30 minutes—1965
made by EBEC films

Relevant Supplementary Films

Human Figure in Art
running time: 16 minutes—1971
made by BFA films—color

Hands
running time: 3 minutes—1965
made by IFB films—color

Ballet with Edward Villela
running time: 27 minutes—1970
made by LCA films—color

Disney's amusing early cartoon *Skeleton Dance* (1913) is available from Museum of Modern Art; expensive to rent and ship but a definite "hit" (Check also films on physical education on running, jumping, wrestling, weight training, etc. See below for rental sources.)

Film Catalogs

R. R. Bowker (P.O. Box 1807, Ann Arbor, Michigan 48106) publishes *The Educational Film Locator*, a catalog of 40,000 educational films. This catalog sells for over $50. For more information, write to the above address.

Rental Services

A selection of major university educational film libraries for films on anatomy.

University of Arizona
Division of Media and Instructional Services
Film Library
Tucson, AZ 85760
(602) 626-3282

Boise State University
Educational Media Services
1910 Col. Boulevard
Boise, ID 83720
(208) 385-3289

Boston University
Krasker Memorial Film Library
765 Commonwealth Avenue
Boston, MA 02215
(617) 353-3272

Brigham Young University
Educational Media Center
290 Herald R. Clark Building
Provo, Utah 84602
(801) 378-2713

University of California
Extension Media Center
222 Fulton Street
Berkeley, CA 94720
(415) 642-0460

University of Colorado
Educational Media Center
P.O. Box 379
Boulder, CO 80309
(303) 492-7341

Eastern New Mexico University
Film Library
Portales, NM 88130
(505) 562-2622

Florida State University
Instructional Support Center Film Library
Seminole Dining Hall
Tallahassee, FL 32306
(904) 644-2820

University of Illinois
Film Center
1325 South Oak Street
Champaign, IL 61820
(217) 333-1360

Indiana University
Audio Visual Center
Stalker Hall
Terre Haute, IN 47807
(812) 232-6311

University of Iowa
Audio Visual Center
C-5 East Hall
Iowa City, IA 52242
(319) 353-5885

Kent State University
Audio Visual Services
330 Library Building
Kent, OH 44242
(216) 672-3456

University of Michigan
Audio Visual Education Center
416 Fourth Street
Ann Arbor, MI 48103
(313) 764-5360

University of North Carolina
Equipment and Technical Services
111 Abernathy Hall
Chapel Hill, NC 27514
(919) 933-6702

Syracuse University
Film Rental Center
1455 E. Calvin Street
Syracuse, NY 13210
(315) 479-6631

University of Texas
Film Library
P.O. Box W
Austin, TX 78712
(512) 471-3573

University of Texas at Arlington
Media Services Center
Box 19647
Arlington, TX 76019
(817) 273-3201

(Check for a local rental source also.)

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O'Malley, Charles D., and C. M. Saunders, J. B. de. *The Illustrations from the Works of Andreas Vesalius*. Cleveland: The World Publishing Co., 1950.

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Richer, Paul Marie Louis Pierre. *Anatomie Artistique*. Paris, 1890.

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Blake, Vernon. *The Art and Craft of Drawing*. London: Oxford University Press, 1927.

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Jack N. Kramer is the author of the first edition of *Human Anatomy and Figure Drawing,* published by Van Nostrand Reinhold. He was a professor of art at Boston University and was awarded the 1982 Thomas B. Clarke Prize by the National Academy of Design.

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